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ENCYCLOPÆDIA MEDICA

UNDER THE GENERAL EDITORSHIP OF

CHALMERS WATSON, M.B., M.R.C.P.E.

VOLUME VIII

MENSTRUATION TO ORBIT

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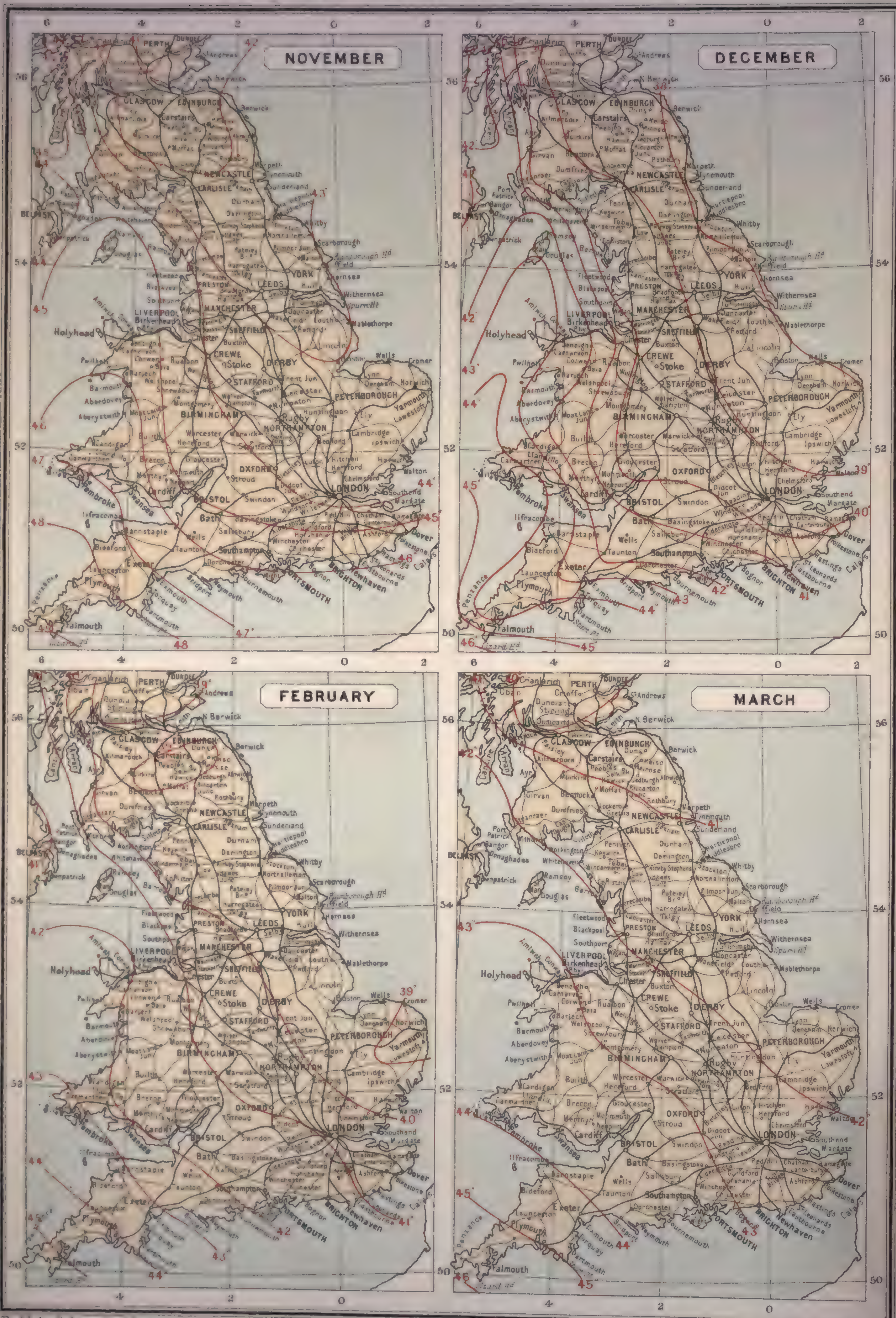

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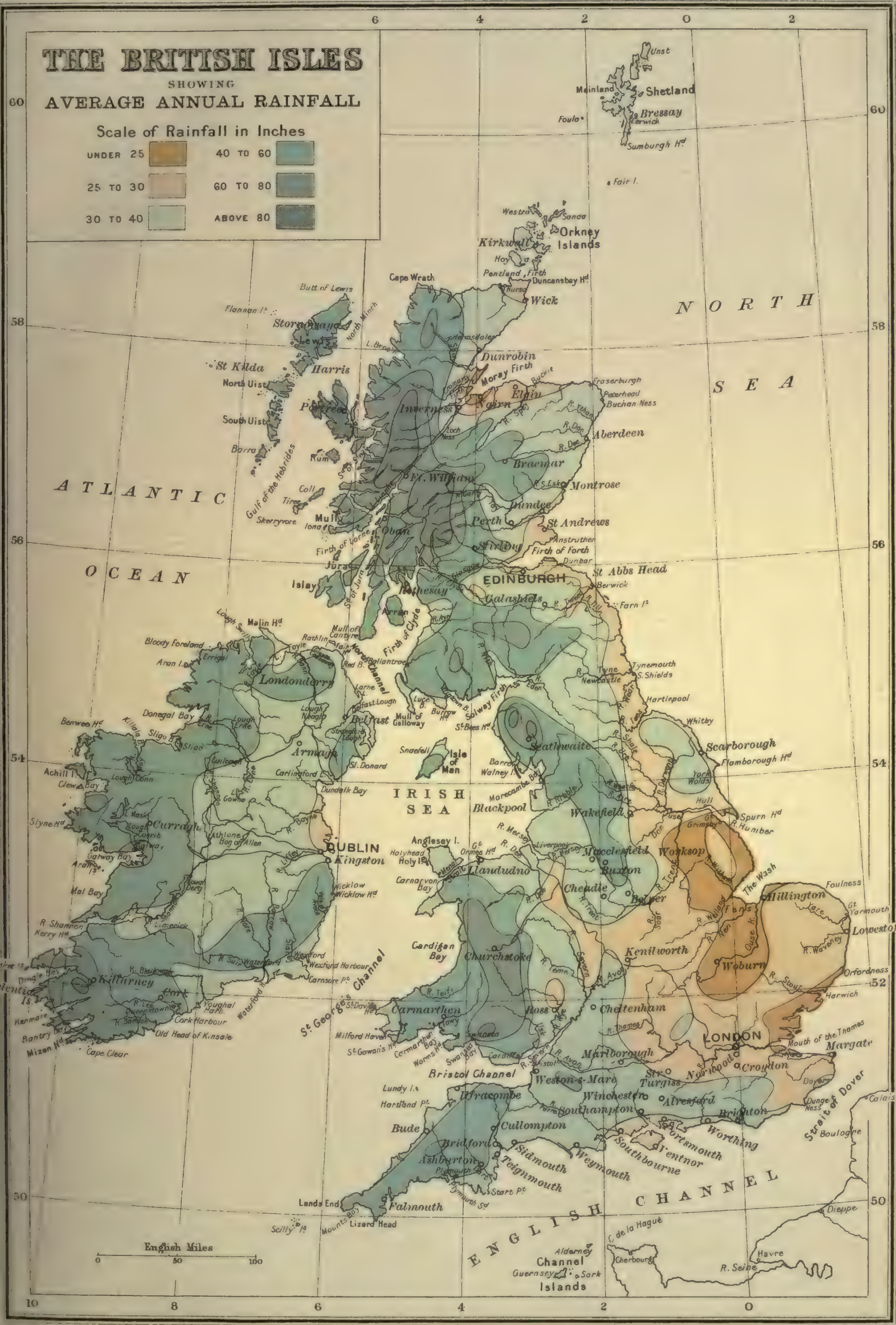

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ENCYCLOPÆDIA MEDICA

Menstruation and its Disorders.

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MENSTRUATION

TERMINOLOGY.—During the reproductive period of a woman's life, from youth to middle age, the mucous membrane of the uterus undergoes at regular intervals a constructive change which has as its object the preparation of a suitable nest for the fertilised ovum. Should conception not take place, a rapid destructive metabolism occurs, the fabric of the half-formed decidua tumbles to pieces, the turgid capillaries burst, and pour out blood which sweeps away the useless tissue debris; and then the whole cycle is repeated. This bloody discharge from the womb occurs in the great majority of women once a month, hence the process has received the name of "menstruation."

The age of the first onset of menstruation is termed "Puberty." Menstruation itself is variously styled "the catamenia," the "menses," the "poorly times," the "monthly periods," the "courses," being "unwell," "having the flowers," etc.

The cessation of menstruation is termed the "menopause," the "climacteric," or the "change of life." Suppression of the menses is called "amenorrhœa"; painful menstruation, "dysmenorrhœa"; excessive loss at the periods, "menorrhagia"; and intermenstrual hæmorrhage, "metrorrhagia." Where the menstrual blood collects and is pent up in the genital canal it is termed "retention of the menses."

PUBERTY.—*Psychical Changes.*—The age of "puberty" is characterised by the onset and establishment of the process of menstruation. It is the springtime of a woman's life, and is marked not only by peculiar physical changes in her figure, gait, and generative organs, but by an equally remarkable transformation in her psychical and mental life. The current of her thoughts is mysteriously changed; hopes and yearnings unknown before thrill and agitate her, and life acquires a new and deeper meaning. The romping tomboy becomes a shy and self-conscious maiden, with finer tastes and emotional fancies. The subtle forces of sex change the girl's soul into the woman's.

Physical Changes.—Before puberty the girl's figure differs but little from the boy's. But now it becomes fuller and plumper, with graceful curves instead of sharp angles. The breasts rapidly develop and become firmer, fuller, and more sensitive. The thyroid gland swells and gives the neck that roundness peculiar to the sex. The voice changes and becomes fuller in compass, richer in quality. The pelvis broadens, the buttock and thighs become more developed, and hair appears on the pubes and in the axillæ. The body of the uterus enlarges, and the mucosa becomes vascular and spongy and discharges blood. The first menstruation is sometimes preceded by certain premonitory symptoms—irritability of the temper, headache, and gastric disturbances, a sense of fulness, weight, and uneasiness in the pelvis and back, and often a mucous discharge from the genitals.

Age.—The age of puberty in Great Britain is usually about the fifteenth year. It is, however, modified by several factors. It occurs earlier in the Tropics (tenth year), and later in the Arctic regions (eighteenth year). The influence of race is conspicuous. Thus Jewesses all over the world begin to menstruate at the same age. Girls born of English parents in India begin at the same age as their sisters living at home, whilst negresses brought up in temperate regions commence as early as they would in Central Africa. Puberty occurs earlier in the idle and wealthy classes than among the hard-working poor, and it is said to occur earlier in girls brought up amidst immoral influences than in the children of virtuous households.

Precocious Puberty.—In rare cases the onset of menstruation, usually with other signs of puberty, occurs prematurely in childhood and even in infancy. Thus in one case a child was born with well-developed mammæ, the pubes was covered with hair, and she menstruated regularly from her third year. Menstruation may indeed appear at any time from a few days after birth to the normal age of puberty. In a few cases there have been the other external signs of puberty without menstruation, and also menstruation without other signs of puberty. Several instances have been recorded where precocious puberty has been associated with pelvic tumours, such as ovarian cysts.

In some of the cases where puberty has occurred precociously conception has taken place, *e.g.*, in children aged from nine to thirteen years.

Delayed Puberty.—In other instances puberty may be abnormally late in manifesting itself without any obvious cause. Thus in one case it did not appear till the twenty-fifth year.

Nubility.—Though normally the menstrual flow is established about the age of fifteen, the body is not physiologically fit for the strain of reproduction till some years later. In temperate climates a woman is not "nubile" till the age of twenty-one, though marriage, conception, and parturition frequently take place much earlier. Statistics show that such premature pregnancies are specially productive of suffering and disease in the mother, whilst the offspring are ill-developed, difficult to rear, and frequently afflicted in body and mind. Too early marriages tend to produce a puny, blighted, deteriorated race.

THE PHENOMENA OF NORMAL MENSTRUATION.—*Periodicity.*—At the outset we are struck by the extraordinary periodicity of the process. In this country the average healthy woman, from the age of fifteen to the age of forty-five, menstruates regularly every twenty-eight days. The menstrual clock is, so to speak, wound up to go for thirty years, and strike once every lunar month—a rhythm of function that suggests that it must be due to rhythmical changes in a controlling nerve centre.

Type.—By the menstrual "type" is meant the number of days from the first day of one period to the first day of the next. It is the index of the woman's regularity. About 75 per cent of healthy women have a twenty-eight-day type, and about 15 per cent a thirty-day type. A few are over or under these limits. We are quite in the dark as to what essentially determines a woman's menstrual type.

Habit.—This term is used to denote the duration of the period. In healthy women it may last from two to eight days—usually from four to five days. From one to two ounces of blood are lost on an average on each day of the period. Clinically we may form a rough estimate of the amount of loss by learning the number of diapers used — allowing about one ounce of blood to each diaper.

The menstrual discharge, when fully established, is a thin dark bloody fluid, somewhat resembling prune juice, of alkaline reaction, and a peculiar heavy odour. In health it is prevented from clotting by the admixture of alkaline mucus. Microscopically it contains red and white blood corpuscles, columnar and cubical epithelium shed from the uterine mucous membrane and the uterine glands, connective-tissue cells, and minute particles of the subepithelial stroma. Mixed with it are numerous squamous epithelial cells from the vagina.

In addition to the flow of blood there is also an increased secretion of the sebaceous glands of the vulva at the onset of menstruation, and an increased secretion of mucus from the uterus and vagina both before, during, and after the period.

The Menstrual Wave.—Professor Stephenson has shown that menstrual life is associated with a well-marked wave of vital energy which manifests itself in a monthly fluctuation of the temperature of the body, of the daily excretion of urea, and of the rate and tension of the pulse. During the day or two preceding the period the temperature rises half a degree above normal, the amount of urea excreted attains its maximum, and the pulse-rate and arterial tension rise. During the period these various phenomena decline to normal, and after the period they fall to below normal. This wave indicates a periodic variation in the general metabolism, probably induced or influenced by the rhythmical activity of the nervous mechanism which controls menstruation.

Nervous and Vascular Symptoms.—Each recurring period is apt to produce disturbances in the woman's nervous system. Even in healthy women it induces a state of increased nervous instability and excitability, whilst lunatics and epileptics are always worse at these times. There is frequently headache, hyperæsthesia, and irritability of the temper. The breasts may be swollen and tender. The thyroid glands may swell markedly. There is often a feeling of weight, fulness, and uneasiness in the pelvis, back, and lower abdomen, and frequently some irritability of the bladder. Pigmentary changes in the skin are not uncommon; for example, such dark areas may form round the eyes as to almost produce the appearance of a double "black eye."

Changes in the Internal Genitals.—There is a general turgescence of the pelvic viscera (uterus, Fallopian tubes, and ovaries) most marked in the uterus, and reaching its acme at the onset of each menstrual epoch. In the ovaries there may or may not be a ripe follicle: it is now well established that ovulation and menstruation are not coincident or consecutive processes. The uterus just before the onset of menstruation is swollen, erect, firm, and deeply congested. As menstruation proceeds its vascularity lessens, its muscular wall becomes softer and laxer, and the canal of the cervix dilates. At the end of the period the uterus has shrunk and become pale and limp.

Changes in the Mucosa.—There are great differences of opinion as to the actual changes that occur in normal menstruation.

1. Sir John Williams held that, in consequence of hæmorrhage into and fatty degeneration of the deepest layer of the mucosa, the whole of the endometrium was shed down to the muscular layer, and that a new mucosa was developed from the bases of the uterine glands. This view was based on autopsies made on patients dying from acute fever, and is now discredited.

2. Engelmann taught that in consequence of fatty degeneration of the superficial layer of the mucosa this alone was shed, the deeper layer remaining.

Pfluger and Tait insisted that a physiological freshening of the mucosa—the removal of its surface epithelium—was necessary for the implantation of a fertilised ovum.

3. Bland Sutton examined a number of human uteri before, during, and after menstruation, and found (*a*) dilatation of the capillaries causing swelling of the mucosa; (*b*) rupture of some of the capillaries, the blood oozing into the stroma and into the cavity of the uterus; (*c*) shedding of only small and quite superficial portions of the epithelium; (*d*) no fatty degeneration.

He also examined the uteri of menstruating baboons and Macaque monkeys, and found congestion and hæmorrhage, but no shedding of the epithelium.

Heape's researches on another monkey (Semno-pithecus Entellus) confirm Sutton's views, viz. that menstruation consists in congestion, hæmorrhage, and shedding of part only of the lining epithelium and subepithelial stroma.

4. Arthur Johnstone's view is that the endometrium is an adenoid gland, that the menstrual discharge takes the place of the lymph stream, and washes away periodically those corpuscles which are too old to form decidual tissue. He holds that the uterine epithelium alone is shed, but the whole mucosa is not exfoliated.

Relation to Ovulation.—Until very recent years menstruation was thought to be directly, or indirectly, brought about by the process of ovulation. Whilst most authorities held this view there was much difference of opinion as to the precise relationship of the two phenomena.

Once a month, in one or other ovary, a Graäfian follicle was supposed to ripen and burst, and discharge its contained ovum into the peritoneum, whence it was carried down the Fallopian tube into the uterus. Some held that this maturation of the follicle reflexly brought about a general turgescence of the internal genitals, and that the rupture of the follicle determined the onset of menstruation. Others thought that the ovum, rather than the Graäfian follicle, was the essential cause; that each month an ovum was carried into the uterus, and (whether fertilised or not) directly stimulated the mucosa to active growth and increased vascularity. In the event of conception occurring the mucous membrane went on growing, and formed the decidua of pregnancy. But if impregnation failed to occur the ovum died, and this brought about a disintegration of the decidua and the phenomena of menstruation. A menstrual period was, according to this view, the abortion of an unfertilised ovum with its decidua—a missed pregnancy, in fact.

It has, however, been shown that ovulation may and does take place independently of and in the absence of menstruation, and menstruation may continue regularly and profusely after the complete removal of both ovaries. Graäfian follicles ripen and burst long before puberty—even in early infancy—and they may continue to do so long after the menopause. Moreover, the maturation of the follicle is by no means coincident with any one phase of menstruation. The observations of Lawson Tait, Annie Clark, and others, have shown that ripe follicles may be found at any time during the period or during the intermenstrual interval. Ovulation goes on during pregnancy, during lactation, and in certain pathological states (such as anæmia) when menstruation is in abeyance. Some women never menstruate and yet ovulate (as is proved by their becoming pregnant). In certain pseudo-hermaphrodites (shown to possess uteri and testes, but not ovaries) menstruation has been observed. For these and other reasons the plausible fascinating ovular theory of menstruation is now generally discarded. At the same time, it is going too far to say that the ovaries have no influence at all on the uterus. There is undoubtedly a most intimate and subtle sympathy between them. It is probable that changes in the ovaries influence the uterus reflexly through the nervous system, and it is possible that the ovaries add to the blood circulating through them some peculiar product of their metabolism, and this "internal secretion" may powerfully modify the uterine functions. Certain it is, that many lesions of the ovary are associated with painful, profuse, or suppressed menstruation, and that complete removal of both ovaries brings about permanent cessation of the periods in 95 per cent of the cases, whilst they continue unaltered if only a portion of one ovary be left.

Relation to the Œstrus.—In many of the lower animals the females at certain intervals pass into a state of sexual activity which is called the "œstrus" or "rut." In popular language the animal is said to be "in heat." The uterus and vagina become swollen and congested, and pour out an increased quantity of mucus sometimes tinged with blood. The vulva becomes moist, turgid, dilated, and hypersensitive. The sexual appetite, usually entirely in abeyance in the intervals, becomes imperative, dominates the animal's actions, and leads her to solicit the male. Now, it has been thought that menstruation in the woman corresponds to and has evolved out of the œstrus in the animal. This may be so, but it is a most significant fact that, both among civilised and savage races all over the world, sexual congress is not permitted during menstruation, whilst amongst animals it is only when in "heat" that coitus takes place, and it is only then that impregnation can occur. It is probable that the "œstrus" is a process evolved by natural selection, with the object of limiting coitus (and therefore conception) to certain seasons of the year, in order that the young might be brought forth under the most favourable conditions of climate and food-supply.

Relation to the Nervous System.—It is highly probable that all the active tissues of the body are under the control of two sets of nerves—

anabolic and katabolic. An anabolic nerve brings about constructive metabolism, produces a building-up of the tissues, repair of waste, a storing up of energy. Examples of this are found in the cardiac branches of the vagus, the chorda tympani, and trophic nerves to muscles. A katabolic nerve stimulates the destructive metabolism which is always going on in the tissues, it brings about a liberation of energy, followed by exhaustion. Examples of this action may be found in the motor nerves of muscles, the accelerator nerve of the heart, and the sympathetic nerve to the submaxillary gland.

Now, in the case of the uterus, the organ is considered to be dominated by anabolic nerves during the intermenstrual interval—engaged in a constructive metabolism, preparing a decidua, building a nest for the expected ovum. But should conception not occur within a definite period the katabolic nerves assert their influence, the actively growing mucosa undergoes a rapid destructive metabolism, its fabric breaks down, its capillaries burst and pour out blood which sweeps away the useless tissue debris. Then once more the uterus comes under the control of anabolic nerves and the whole cycle is repeated.

But should impregnation occur the anabolic influence is augmented and continued until the close of gestation, constructive metabolism goes on uninterruptedly, and the uterus actively grows. Menstruation being a katabolic process is in abeyance. But, at the end of the nine months of gestation, katabolic forces gain the upper hand, and parturition (involving a great expenditure of energy) takes place. Then the uterus, by the process of involution, a destructive metabolism, slowly returns to its normal condition.

Geddes and Thomson hold that menstruation has an important relationship to the balancing of anabolism and katabolism in the female. After puberty, anabolism (or storing up of energy and building up of tissue) preponderates over katabolism. In pregnancy this surplus is spent in nourishing the fœtus; in lactation, in feeding the child; and at other times, in menstruation. They look upon it as a highly specialised process, developed in the evolution of the higher Mammalia (monkeys and man), by which the two great forces of the body-metabolism (anabolism and katabolism) are properly balanced. The menstrual flow is only the most obvious outward and visible sign of this process.

It is probable that menstruation is directly governed by special nerves emanating from a special nerve centre in the lumbar enlargement of the spinal cord. In many organs of the body there is a periodic variation in activity, and in every instance known this may be traced to a rhythmical emission of nerve force from a special controlling centre. As examples of such centres may be cited the cardiac, respiratory, vasomotor, and splenic centres. The nervous disturbances which manifest themselves at puberty, at the menstrual period, and at the menopause, indicate an intimate connection between the process of menstruation and the central nervous system.

The uterus is supplied on each side by two plexuses—the ovarian plexus and the utero-vaginal plexus. The ovarian plexus is derived from the aortico-renal plexus. Filaments from the last dorsal and upper four lumbar nerves have been traced into it. It accompanies the ovarian artery, sends branches to the ovary and Fallopian tube, and after communicating in the broad ligament with the utero-vaginal plexus ends in the uterus.

The utero-vaginal plexus is derived from the hypogastric plexus, into which the "pelvic splanchnics" from the second and third sacral nerves pass. The nerves destined for the uterus accompany the branches of the uterine artery between the layers of the broad ligament, where they communicate with the ovarian plexus. There are numerous ganglia in the plexus. A large one situated on the cervix has been termed the "ganglion cervicale uteri." Nerve filaments have been traced into the mucous membrane of the uterus, where, according to Frankenhäuser, they end in ganglia. The pelvic splanchnics arise in the lumbar cord, in the cells of the posterior vesicular column of Clark, being also connected with the cells of the lateral horn. They emerge in the roots of the second and third sacral nerves, and without entering the chain of lateral ganglia, pass directly into the hypogastric plexus, from whence they are distributed to the pelvic viscera. They are chiefly vaso-dilator in function, bringing about that vascular engorgement in the uterus and appendages which is such a marked feature of menstruation. The position of the menstrual centre can only be surmised, but it is probable that it is situated in the lumbar enlargement of the spinal cord. This portion of the cord is intimately associated with all the pelvic functions. It has been proved to contain, in the human being, centres for micturition, defecation, erection, and ejaculation. Experiments in animals have demonstrated that it contains a parturition centre in the bitch, and there is probably one there also in the woman. And if the parturition centre be found there, the menstrual centre will not be far away.

THE MENOPAUSE.—The "menopause," "climacteric," or "change of life" is essentially characterised by the cessation of the menses. Of women living in a temperate climate, in 25 per cent it occurs between the ages of forty and forty-five, and in 50 per cent between forty-five and fifty. In a small minority of cases it occurs under forty or over fifty. It takes place later in women living in cold than in hot climates, and later in those who live a luxurious, lazy life than in the hard-working poor. Jewesses living in this country have the change somewhat earlier than other women.

It is the autumn of a woman's life. Her summer with its blossom and fruit has passed; her reproductive forces have spent themselves. She begins to feel the burden of years and the approach of old age.

The menses cease sometimes abruptly, more often gradually. The periods become irregular—the flow being sometimes excessive, sometimes scanty. The intermenstrual intervals alter, usually becoming more and more prolonged. In some women there is nearly constant dribbling of blood, alternating with severe floodings. This period of irregular fitful losses is often spoken of as the "dodging time."

The woman's figure alters and loses much of its grace. Most women put on fat, especially in the abdomen. Occasionally this is so marked as to suggest pregnancy or abdominal tumour. Others, especially if they be unmarried, become lean and scraggy. The skin loses its bloom and fineness of texture, and becomes coarse, opaque, and wrinkled. In a few cases the figure becomes more masculine, and straggling hairs develop on the chin, cheek, or upper lip. The breasts become either shrunk and atrophied or loaded with fat. The fat about the vulva disappears, and the labia become flaccid folds of skin. The ostium vaginæ becomes smaller, and all the tissue of the external genitals tougher and less resilient. The vagina becomes shorter, narrower, smoother, and less elastic. The upper end of the vagina contracts, and the fornices tend to become obliterated. The uterus atrophies—becomes shorter, narrower, less vascular, and diminished in weight. The cervix projects less into the vagina. The endometrium becomes paler, thinner, and more fibrous, and the glands disappear. The ovaries become small, hard, and wrinkled; the Graäfian follicles disappear; and the stroma contracts into a knot of dense fibrous tissue.

Coincident with these physical changes there are marked nervous, especially vasomotor, disturbances. The most frequent phenomena are heats and flushes, irregular palpitations, profuse perspirations, and feelings of giddiness, faintness, and exhaustion. There may be morbid fears, mental depression, loss of memory, and irritability of temper. She may complain of numbness and tingling in her hands and feet. At other times there is a condition of hyperæsthesia of the special senses, so that noises, smells, and lights, which formerly she would not have noticed, distress and agitate her. In some cases the mental disturbance verges on insanity; she becomes suspicious of those around her; has fixed delusions, and suicidal or homicidal impulses. In others there is marked moral perversion, especially a craving for alcohol. With the cessation of the menses, the sexual appetite usually wanes, but in a few cases it becomes distressingly intense.

The climacteric renders a woman peculiarly liable to certain diseases. Amongst these may be mentioned cancer (especially of the uterus and breast), pruritus vulvæ, prolapse of the vagina and uterus, urethral caruncle, kraurosis vulvæ, disorders of digestion (such as nausea, heartburn, flatulence, and constipation), some forms of insanity, gout, and diabetes. (See "Climacteric Insanity," vol. ii., and "Menopause," vol. vii.)

The change of life may be induced prematurely by—(1) The complete removal of the uterus, or both uterine appendages by operation. (2) The complete functional destruction of both ovaries by disease, such as advanced cirrhosis, new growths, and inflammation. (3) Any cause of great nervous depression, such as shock, fright, anxiety, and exposure to cold. (4) Exhausting diseases, such as phthisis, prolonged hæmorrhages, acute fevers, chronic alcoholism, myxœdema, and diabetes.

The climacteric may be delayed much beyond the normal, usually in consequence of some local pelvic disease, such as myoma, cancer, or endometritis.

VICARIOUS MENSTRUATION.—By this is meant a discharge, usually of blood, from some part other than the uterus, occurring once a month, and apparently taking the place of the normal menstrual discharge. In most of these cases menstruation proper is very scanty or entirely in abeyance. It is a rare and puzzling condition, and its etiology is obscure. It is supposed (1) that there is some morbid condition of the uterine mucosa which interferes with the natural outpouring of menstrual blood; (2) that there is at each period a condition of high vascular tension; and (3) that in consequence of some weakness of the capillaries in another part of the body, hæmorrhage there occurs. It has been observed from the gums, the nose, the stomach, the rectum, the lungs, the bladder, the breast, the conjunctiva, the unbroken skin, and from open wounds and ulcers. In some cases, in place of a flow of blood, there is a monthly discharge of milk (in the case of the breasts) or diarrhœa (in the case of the bowels).

THE HYGIENE OF MENSTRUAL LIFE

1. *Puberty.*—At this period of a girl's life it is important that she be not subjected to any great mental or physical strain. She must lead as quiet and even a life as possible, be warmly clad, have a simple, easily digested dietary, take moderate exercise in the open air, and regulate her bowels. It is advisable at this time that her mother or some judicious friend should explain to her the meaning of the menstrual flow, and impart to her some of the rudimentary facts of sexual physiology. (See "Puberty.")

2. *The Menstrual Period.*—Although this is a physiological process, it is

so frequently disordered and painful that it is commonly looked upon as a pathological condition. The patient describes herself as "being unwell" or "being poorly." It is important that during menstruation she should rest as much as possible in the recumbent position if the periods be excessive or painful. She should take light, unstimulating diet, and see that her bowels are kept freely open. All severe nervous strain or muscular exertion must be avoided. Locally she must keep the genitals as clean as possible by bathing the vulva in warm water, and changing her diapers when soiled. Many women have a foolish objection to washing themselves during their periods; but a warm bath is not only harmless, but soothing and beneficial at these times. A warm vaginal douch (at 100° F.), to which a little boracic acid has been added, is often comforting during the period. It is not advisable to perform any surgical operation—unless it be imperative—during menstruation, as the woman's nervous system is in an excitable, hypersensitive condition. Moreover, the menstrual secretion is an excellent culture medium for germs, and might be a source of sepsis. In particular, operations on the uterus should be avoided, as these organs are in a turgid, excitable state, and thus prone to bleed or become inflamed. The best time to operate on a woman is usually during the week after menstruation has ceased.

3. *The Menopause.*—We have now, as a rule, marked nervous disturbances, heats and flushes, palpitations, depression of spirits, etc. The patient must be encouraged as much as possible, and assured that these symptoms which so distress her are natural and to be expected at her time of life, that she must have patience, and in due season they will all subside. If they be severe, much relief may be obtained by administering bromide of potash with belladonna, and, if this fails, by giving tabloids of ovarian tissue. She must be warned not to take alcohol, the temptation to take stimulants being very great at the menopause. Her medical attendant must ever bear in mind how prone women are at this time to develop malignant disease, especially in the breast and uterus. He must, therefore, insist on a thorough examination should the patient manifest any symptom of this dreadful malady.

AMENORRHŒA.—By amenorrhœa we mean absence or suppression of the menstrual flow. It must not be confounded with "retention of the menses"—a condition in which the menstrual blood is poured out, but, from atresia of part of the genital canal, cannot find exit and collects within the body.

It is convenient to distinguish between primary and secondary amenorrhœa.

Primary amenorrhœa signifies the absence of the menses in a woman who has never menstruated.

Secondary amenorrhœa means the cessation of the menses, temporarily or permanently, after the onset of puberty and the regular establishment of the monthly flow.

I. PRIMARY AMENORRHŒA.—It would seem that for the normal occurrence of puberty three factors are necessary:—(1) A normal condition of the blood. (2) A normal condition of the nerve centres. (3) A normal development of the internal genitals. If any of these factors be at fault the menses may fail to appear. We shall, therefore, consider cases of primary amenorrhœa under three headings:—(*a*) Those due to faults in the blood. (*b*) Those due to nervous disturbances. (*c*) Those due to errors of development.

(*a*) *Primary Amenorrhœa due to Faults in the Blood.*—Certain debilitating diseases, such as tuberculosis, Bright's disease, and chlorosis may develop before the normal age of puberty. When the time for this arrives the blood is so impoverished that the processes necessary for the production of menstruation cannot take place. Puberty is delayed for months or years. When, finally, the periods do appear, they are apt to be irregular, occurring at long intervals and lasting only a few hours, the discharge being scanty in amount and pale in colour.

(*b*) *Primary Amenorrhœa due to Nervous Causes.*—This is apt to occur in two classes of the community—(1) Amongst the upper classes in girls who are subject to mental over-work, such as cramming for examinations. (2) Amongst the lower classes in girls who are put to physical labour too great for their strength. In these cases the blood may be normal, and there may be no defect in the development of the genitals. The body is ripe for puberty; but, from the over-taxing of the brain or the body, the necessary nerve force is diverted into abnormal channels, and the phenomena of puberty do not appear.

(*c*) *Primary Amenorrhœa due to Defects of Development.*—In some of the cases the uterus, ovaries, and tubes are entirely absent, or, if present, remain in the infantile condition. The external signs of puberty fail to appear; the breasts remain small and flat; there is an absence of hair on the pubes, and the vulva resembles that of a child. There is also an absence of the psychical phenomena of puberty, and the emotions and instincts of sex do not develop.

In other cases where menstruation fails to appear there is a development of many of the sexual characters of the male. The body acquires a distinctly masculine type. The pelvis remains narrow. Hair develops on the abdomen and chest and sometimes on the upper lip, chin, or cheeks. The voice, the gait, the figure, and the tastes become "mannish." Occasionally there is an extraordinary development of the muscular system, and hence probably the female "Samsons" and "Hercules" of the shows. The external genitals may be quite normal, but the uterus is either absent or feebly developed. These masculine women rarely menstruate. If they do, puberty is much delayed, and when the periods do appear they are irregular and scanty—a mere apology for menstruation.

II. SECONDARY AMENORRHŒA.—This may be caused by either local or general conditions:—

Local Causes.—1. Pregnancy and lactation. 2. Hysterectomy. 3. Atrophy of the uterus. 4. Oöphorectomy. 5. Diseases of the ovaries.

General Causes.—1. Anæmia. 2. Nervous disturbances. 3. Disorders of metabolism.

Amenorrhœa in Pregnancy and Lactation.—The menses are physiologically absent in utero-gestation and lactation. Normally, a woman ceases to menstruate from the time of conception till the end of lactation—a period of eighteen or twenty months. Of all the symptoms of pregnancy, amenorrhœa is the most constant. It is not, however, invariable, as some women menstruate regularly during the first three or four months of gestation, and in rare instances throughout the whole nine months. This is explained by the non-fusion of the decidua vera with the decidua reflexa, whereby the endometric cavity is preserved. Some women always menstruate during lactation. In tubal pregnancy there is generally a short period of amenorrhœa, from five to eight weeks, followed by irregular losses. In abdominal pregnancy there is often total suppression of the menses as long as the child is alive. After it dies the periods reappear.

In both tubal and abdominal pregnancy, however, menstruation may continue unaffected.

Amenorrhœa after Hysterectomy.—It is obvious that if the uterus—the menstrual organ—be completely removed by abdominal or vaginal section, menstruation must cease. If, however, only partial hysterectomy be performed, as in the clamp and sub-peritoneal methods, it is possible for the periods to continue. In such cases it will be found that a portion of the uterus above the level of the os internum has been left behind.

Amenorrhœa from Atrophy of the Uterus.—After parturition the uterus undergoes a physiological atrophy called "involution." The hypertrophied muscular fibres contract and undergo a process of fatty degeneration. The enlarged blood-vessels shrink, and the blood sinuses become occluded. The greater part of the decidua undergoes fatty degeneration and melts away in the lochial discharge. Only the deep glandular layer next to the muscular coat remains, and from it the new mucosa is built up. The surface epithelium is formed from the epithelium of the remnants of the glands. By the end of the fifth week after delivery the new mucous membrane is, as a rule, complete. Normally, however, the uterus never quite returns to its virgin condition, the parous uterus being distinctly larger than the nulliparous.

Occasionally, after severe post-partum hæmorrhage, or too prolonged lactation, the process of involution progresses beyond the normal, and the uterus undergoes extreme atrophy or superinvolution. A similar condition of atrophy of the uterus may be induced, quite apart from delivery, by certain debilitating diseases, such as tuberculosis, syphilis, Bright's disease, and profound anæmia; also by chronic pelvic inflammation, severe enough to destroy the ovaries or interfere with the blood supply of the uterus.

However caused, this atrophy of the uterus is characterised by complete and permanent cessation of menstruation. The uterus shrinks till it may be little more than an inch long, with thin flaccid walls and a pale thin fibrous mucosa.

Amenorrhœa after Oöphorectomy.—If the uterine appendages be removed on one side only, menstruation is not interfered with. If they be completely removed on both sides, the operation brings about, in 95 per cent of the cases, permanent cessation of the menses and a premature menopause. This post-operation climacteric is accompanied by the same peculiar nervous disturbances as characterise the natural change of life.

Amenorrhœa from Disease of the Ovaries.—Ovarian tumours do not, as a rule, interfere with menstruation; but sometimes they cause very scanty catamenia and occasionally total amenorrhœa. This is especially apt to occur when both ovaries are affected.

After severe double oöphoritis and in cases of advanced sclerosis of the ovaries, menstruation may entirely cease. In these cases there is complete destruction of the ovaries as functional organs.

Amenorrhœa from Anæmia.—The most frequent causes of amenorrhœa, exclusive of pregnancy, are those due to debilitating diseases which impoverish the blood. Such are tuberculosis, Bright's disease, malaria, and other fevers, syphilis, and especially chlorosis. All these diseases produce more or less anæmia; and it is the anæmia, rather than any specific effect of the disease on the uterus, which causes the amenorrhœa.

Chlorosis is a disease which has some mysterious relationship to the functions of the female sexual organs. It never occurs in the male sex, and is peculiar to adolescent females. It is most common between the ages of fifteen and twenty years. It is seldom seen in married women, and hardly ever in those who have borne children. It is most apt to occur in the ill-fed, over-worked girls of large towns, who sleep and labour under insanitary conditions. Amongst accessory causes are want of out-door exercise, want of sunshine, tight lacing, and disappointment in love. It is characterised by pallor—in advanced cases, of a greenish yellow tint—breathlessness and palpitation on exercise, constipation, indigestion, and amenorrhœa. Loud hæmic murmurs are heard over the heart and root of the neck. The essential change in the blood is a remarkable diminution of hæmoglobin, together with a slight diminution in the number of red corpuscles.

Amenorrhœa from Nervous Disturbances.—In some young women a mere change of environment will arrest the periods. Thus a long sea voyage, a visit to the continent, a change of residence from the country to the town or *vice versa*, will bring on amenorrhœa—usually only temporary—without any other signs of disease. It is probable that this amenorrhœa is brought about by nervous influences.

A violent nervous shock, such as suddenly receiving bad news, may cause temporary or permanent cessation of the menses. Probably also severe chills, as from exposure to cold and wet, act through the nervous system in causing a passing amenorrhœa. In certain forms of insanity, especially melancholia, and the insanity of adolescence, there is often suppression of the menses. In cases of "pseudo-cyesis" where, by a process of auto-suggestion, the patient believes herself to be pregnant, there is not only amenorrhœa, but a remarkable simulation of the other symptoms of pregnancy. Thus a young, recently-married woman, who ardently desires to have a child, ceases to menstruate and imagines she has conceived. Her abdomen and breasts swell, she suffers from morning sickness, and may even fancy she feels the fœtal movements. She consults a medical man, who examines her and finds an absolutely normal non-gravid uterus.

Or an unmarried woman, who in a weak moment has permitted coitus to take place, becomes alarmed less she be pregnant. Her fright itself brings about a stoppage of the periods, and this in turn intensifies her mental distress. At last, in desperation, she consults a medical man, who examines her, but finds no sign of pregnancy.

Amenorrhœa from Disordered Metabolism. There are certain cases of amenorrhœa which are associated with obesity and with plethora. It is probable that the amenorrhœa neither causes nor is caused by either of these conditions; but that both sets of phenomena are expressions of a disturbance of the general metabolism. We may suppose that in such cases the anabolic forces of the body acquire undue predominance, whilst the katabolic influences are in abeyance. This abnormal anabolism leads to an excessive building up of adipose tissue, or to an excessive formation of blood; whilst menstruation, being a katabolic process, is suppressed. It is possible that this disturbance of the balance of anabolism and katabolism is due to some fault in the internal secretion of the ovary. Whatever be the explanation, there can be no doubt of the clinical facts, viz. that we not infrequently see cases of amenorrhœa associated with excessive obesity and (though more rarely) with a tendency to plethora. It is probable that the amenorrhœa of myxœdema is to be accounted for in a similar fashion, viz. as an expression of a disturbance of metabolism.

TREATMENT OF PRIMARY AMENORRHŒA.—(1) *Due to Anæmia.*—We must improve the quality of the patient's blood, and try and remove the cause of the general debility. Thus chlorosis must be treated with iron and arsenic, saline aperients, good food, and fresh air. In cases of tuberculosis, cod-liver oil, iodide of iron, and the hypophosphites are indicated. In Bright's disease, diuretics, diaphoretics, and aperients should be given as required, whilst rest, milk diet, and avoidance of cold and wet must be enjoined. When the symptoms of the general disease subside and the quality of the blood improves, signs of puberty will manifest themselves, and menstruation become established.

(2) In cases of amenorrhœa due to mental or physical overstrain, the treatment is simple; we must remove the cause. Rest must be given in the one case to the overtaxed brain, and in the other to the exhausted body, and in due course puberty will appear. All who are placed in charge of girls, such as mothers and school-mistresses, should be warned of the evils that may follow either mental or physical over-work at this period of a girl's life.

(3) Cases of primary amenorrhœa due to defects in development are very unsatisfactory to treat. When the uterus is congenitally absent, it is, of course, folly to expect, by any line of treatment, to bring on menstruation. For the masculine type of women with amenorrhœa, as a rule, nothing can be done. They must make up their minds to pass through life as they are, and bear the burden of their sexual anomaly to the grave.

In cases where there is only a small and poorly-developed uterus, with delay in the onset of puberty, tabloids of ovarian tissue, together with general blood tonics (such as iron, arsenic, and manganese), may be administered with some hope of success.

TREATMENT OF SECONDARY AMENORRHŒA.—(1) *In Pregancy and Lactation.*—The amenorrhœa of normal pregnancy and lactation calls for no treatment; it is a physiological condition. In every case of absence of the menses, whether in the married or single, the physician should always first satisfy himself that the patient is not pregnant before commencing active treatment. He should also bear in mind that it is possible for a suckling woman to conceive. The amenorrhœa due to ectopic gestation does not itself call for treatment—it is only a symptom of a grave pelvic lesion. But this lesion calls for active treatment most urgently. A surgeon should be called in without delay, as in the great majority of cases an operation for the removal of the pregnancy is necessary.

(2) *After Hysterectomy.*—Nothing can be done, even were it desirable, to restore the menstrual function in these cases.

(3) *In Atrophy of the Uterus.*—Here the lesion is almost invariably a permanent one, and it is futile to attempt by treatment to restore the lost menstrual function.

(4) *After Oöphorectomy.*— Here also we cannot expect to recall the catamenia. We can, however, do something to relieve the distressing nervous symptoms that supervene. These symptoms are much more severe after double oöphorectomy than after hysterectomy (without sacrifice of the ovaries) and are probably due to the want in the system of the internal secretion of the ovary. Certain it is that we can greatly mitigate them by administering tabloids of ovarian tissue, just as we can remove the symptoms of myxœdema by giving thyroid tabloids.

(5) *In Disease of the Ovaries.*—Here it is the primary disease of the ovary, and not the secondary amenorrhœa, that calls for treatment.

(6) *In Anæmia.*—In amenorrhœa caused by anæmia our first aim should be to cure the primary disease which has impoverished the blood. Thus tuberculosis, malaria, syphilis, and Bright's disease must each be treated *secundum artem.* If the anæmia persists, hæmatinics, such as iron, arsenic, and manganese, are indicated. As the primary disease subsides and the quality of the blood improves, the menstrual functions will return.

Let us now consider with somewhat more detail the treatment of amenorrhœa due to chlorosis—the most common cause of the condition and the one most amenable to treatment. This consists essentially in the administration of large doses of iron, in a form easily assimilated and least likely to upset the digestion. The best preparation of iron is undoubtedly ferrous carbonate (in the familiar form of Blaud's pill). The citrate of iron and ammonia, and the various chalybeate waters are also valuable. In nearly all cases there is obstinate constipation, and it will be found that unless this be overcome, the iron is of little use. It is necessary, therefore, to regulate the bowels with saline aperients (such as sulphate of magnesia), aloes, or cascara. A time-honoured and most efficacious mixture is that containing sulphate of iron, sulphate of magnesia, dilute sulphuric acid, glycerine, and peppermint water. Inferior to iron, but often usefully given in combination with it are arsenic and manganese, whilst quinine, nux vomica, and calumba are useful adjuvants. The digestion must be attended to, and if there be chronic gastric catarrh this should be remedied (before commencing the course of iron) by rhubarb and soda, etc. The diet must be regulated. The patient must avoid strong tea, and all highly spiced and indigestible dishes. An abundance of wholesome blood-forming food (milk, eggs, red meat, and beef-juice) should be given. Alcohol is not usually necessary, but in some cases the light red wines, such as Burgundy, seem to hasten recovery. In the case of the girl who is overtaxing her brain (as in schools) or her body (as in domestic service and factories), it is important to give her a complete rest or change of occupation. If her strength permit she should take judicious exercise, short of fatigue, in the open air and sunshine. If there be any suspicion of tight lacing, this must be prohibited, and the girl taught how to dress rationally.

(7) *From Nervous Disturbances.*—As a rule, amenorrhœa from nervous causes is only temporary, and the periods return when the cause is removed. In cases of pseudo-cyesis the best method of restoring the menstrual flow is a correct diagnosis. Convince the patient that she is not pregnant and the uterus will soon resume its functions.

When due to mere change of climate, the amenorrhœa will cease when the patient has become acclimatised to her new surroundings or when she returns to her old home. Exposure to cold and wet may stop the period for one month, but rarely longer.

A violent nervous shock, on the other hand, may cause a permanent arrest of menstruation and a premature menopause.

In these cases of nervous amenorrhœa the first essential is the removal of all causes of nervous disturbance. A change of scene and change of occupation and cheerful surroundings are advisable. If there be nervous excitement, sedatives, such as bromide of potash and chloral, may be needed. If there be nervous depression, tonics, such as strychnine and damiana, are useful. If there be a tendency to anæmia, iron and arsenic are called for. If there be constipation, alœs and cascara should be given.

Should these various measures fail to restore the periods, then emmenagogues (drugs which act as uterine stimulants) should be tried. The most useful of these are senecio, apiol, caulophyllum, pulsatilla, manganese, and tabloids of ovarian tissue.

8. *From Disordered Metabolism.*—In amenorrhœa associated with obesity, plethora, or myxœdema, it is more important to treat these conditions than the amenorrhœa. The tendency to obesity must be combated by a strict "anti-fat" regimen, out-door exercise, vapour baths, and aperients. Tabloids of thyroid gland are often very efficacious, not only in reducing the excess

of fat, but also in restoring the functions of the uterus. It is, however, a remedy which must be carefully watched, as in some cases it causes alarming palpitation and cardialgia.

The plethoric cases require a spare, non-stimulating diet, plenty of outdoor exercise, saline aperients, and vascular and nervine sedatives—especially bromides, valerian and aconite. Stimulants (such as alcohol, tea, and coffee) and tonics (such as iron and strychnine) must be avoided, as they will only aggravate the symptoms of plethora. In severe cases occasional bloodletting is decidedly beneficial.

For the myxœdematous cases there is one sovereign remedy—tabloids of thyroid tissue. As the myxœdema subsides, the menstrual periods become re-established.

MENORRHAGIA AND METRORRHAGIA

By *menorrhagia* is meant excessive menstruation.

This may be due to three factors—(*a*) A change in the "type," *e.g.* instead of the period occurring every four weeks it may appear every three weeks. (*b*) A change in the "habit," *e.g.* instead of lasting from four to six days it may last ten or twelve. (*c*) A change in the amount of blood lost each day, *e.g.* instead of a patient using one or two diapers daily, she may soil three or four a day.

Whichever factor be modified, the ultimate result is an abnormal drain of blood from the body. All three factors may be altered: thus a patient (who previously menstruated every twenty-eight days, for four days, using one diaper a day) may come on unwell every twenty-one days, for seven days, using three diapers a day.

In determining, therefore, whether or not a given patient's menstruation is excessive we must take into consideration her "type," her "habit," and the number of diapers soiled.

By *metrorrhagia* is meant hæmorrhage from the uterus at other times than the monthly periods. It is independent of the menstrual process, and is quite irregular in frequency, duration, and quantity.

In some cases, as where there is cancer and myoma, the patient suffers from both menorrhagia and metrorrhagia.

CAUSES.—The causes of hæmorrhage from the uterus are many and varied. They may be considered under two headings—(1) those which are general, systemic, or predisposing; (2) those which are local, pelvic, or exciting causes.

1. *General Causes.*—(*a*) Any disorder of the system which diminishes the coagulability of the blood or which lessens the resistance of the capillary walls. Amongst these may be classed such blood diseases as purpura hæmorrhagica, scurvy, hæmophilia, acute fevers (such as small-pox, typhus, and malaria), cholæmia, cirrhosis of the liver, chronic alcoholism, phosphorus poisoning, and lead poisoning.

(*b*) Any condition which causes increased backward pressure in the abdominal veins and chronic venous congestion of the pelvic viscera, such as valvular heart disease, cirrhosis of the lung, emphysema, constipation, tight lacing, and abdominal tumours obstructing the pelvic veins.

2. *Local Causes.*—These act (1) by causing acute or chronic engorgement of the pelvic viscera in general, and of the uterus in particular; or (2) by causing a direct breach of the uterine mucosa.

(*a*) Certain Complications of Pregnancy.—The most common of these are placenta prævia, partial separation of the placenta, threatened abortion, and vesicular mole. In all these conditions the essential cause of the bleeding is a partial separation of the placenta, tearing open the uterine venous sinuses, whilst at the same time the uterus cannot contract and retract because of its contents.

(*b*) Certain Complications of the Puerperium.—Such are inversion of the uterus, sub-involution and retention of portions of placenta. The latter condition is an extremely common cause, and should always be suspected when after a miscarriage or full time labour irregular floodings occur and recur in spite of rest, ergot, and hydrastis.

(*c*) The various lesions of ectopic gestation, such as ruptured tubal pregnancy, tubal abortion, and pelvic hæmatocele. The uterine mucosa becomes hypertrophied and hyperæmic, and is often discharged as a complete decidual cast of the cavity of the uterus. In many cases this decidua acts as a foreign body in the uterus, and is the exciting cause of the hæmorrhages. It acts, in fact, much as a piece of retained placenta or a polypus does.

(*d*) Any acute or chronic inflammation in the uterus, tubes, or ovaries may give rise to menorrhagia and metrorrhagia. In the case of the uterus there may be metritis, endometritis, and erosion of the cervix; in the tubes there may be salpingitis and pyo-salpinx; in the ovary oöphoritis and ovarian abscess. Of these various lesions endometritis is the most frequent cause of uterine hæmorrhagia, partly from its causing increased vascularity of the mucosa, partly from the capillary walls becoming friable and easily ruptured. In some cases there is a direct breach of the mucous membrane from a process of ulceration.

(*e*) Certain Displacements of the Uterus, such as Retroversion and Prolapse.—It is probable, however, that in these cases the hæmorrhage is due not so much to the displacement as to the accompanying metritis and endometritis. Certain it is that in many cases of very marked prolapse there is no increase whatever in the menstrual loss.

(*f*) New growths in the uterus and ovaries are very common causes of menorrhagia and metrorrhagia. In the uterus there may be a polypus, myoma, epithelioma, carcinoma, or sarcoma. In the ovaries there may be cystoma, fibroma, sarcoma, or carcinoma.

Of these myomata are frequently the cause in youth and early middle life, from 25 to 40, whilst cancer is always to be watched for in women between 40 and 60 years of age.

Myomata cause the periods to become more and more profuse, to occur at shorter and shorter intervals, and to last longer. The nearer the myomata to the mucosa the greater the hæmorrhage. Thus submucous fibroids cause more loss than do the interstitial growths. In many of these cases there is co-existing endometritis, and from this no doubt comes much of the bleeding. In the case of big myomata the veins of the broad ligament are pressed on, and this causes uterine congestion and hæmorrhage.

When tumours of the ovaries cause menorrhagia or metrorrhagia it is usually due to their pressing on the pelvic veins and hindering the return of blood from the uterus. In most cases of ovarian cyst menstruation is unaffected; in a few it is scanty or suppressed; in a few it is excessive.

In young unmarried women uterine hæmorrhage is generally due to some systemic cause.

In mature married women the most common causes are those connected with pregnancy, pelvic inflammations, and myomata.

In women at and beyond the climacteric the most common cause is cancer.

In young single women it is not usually necessary to make a vaginal examination, unless the hæmorrhage be severe or medicinal treatment fail to check it. In all other cases the importance of making, without delay, a thorough pelvic examination cannot be too strongly urged. This is especially necessary in metrorrhagia occurring at or after the menopause, and so often due to malignant disease. The only hope of cure of this dreadfully prevalent malady lies in its removal in the earliest possible stage, and for this its prompt recognition is essential. If a simple bimanual examination does not clear up the diagnosis, the cervix should be dilated, the interior of the uterus explored with the finger and curette, and the scrapings examined microscopically by a competent pathologist.

The *symptoms* of menorrhagia and metrorrhagia are those of acute or chronic hæmorrhage superadded to those of the primary disease causing it.

Treatment.—In most cases of uterine hæmorrhage there are three main lines of treatment—(1) attention to the general health; (2) the removal of any local cause; (3) the arrest of the hæmorrhage.

1. *The General Health.*—(*a*) A careful examination of the various systems should be made in order to discover any general disorder which might cause, predispose to, or aggravate the loss of blood; and this systemic lesion must be treated *secundum artem.*

(*b*) The patient must be kept absolutely at rest, both bodily and mental. The recumbent posture must be insisted on, and all causes of worry and excitement removed. Coitus must be interdicted.

(*c*) If there be either acute or chronic pelvic congestion the bowels should be kept freely open with saline aperients in order to deplete the abdominal veins.

(*d*) If the patient be plethoric the uterine hæmorrhage should not be checked unless excessive. It may be a valuable safety valve to the surcharged circulation. In some cases of valvular heart disease, also, a moderate amount of menorrhagia does good by diminishing the venous turgescence and relieving the labouring right ventricle.

(*e*) As a general rule, it is not wise to give iron internally in cases of anæmia due to menorrhagia and metrorrhagia, as it frequently aggravates the uterine losses.

2. *The Treatment of the Local Cause.*—If, on examining the pelvis, a definite local cause be found, this should if possible be removed. With the removal of the cause the hæmorrhage will cease.

(*a*) If there be placenta prævia, accidental hæmorrhage, or vesicular mole, the uterus should be emptied without delay and the pregnancy terminated.

(*b*) If there be a retained fragment of placenta this should be removed with the curette. An inverted uterus must be reduced by manipulation, elastic pressure, or surgical operation. If there be subinvolution, ergot and chlorate of potash should be administered, rest enjoined, and saline aperients ordered. In obstinate cases curetting is necessary.

(*c*) If there be an ectopic gestation it should be removed without delay by surgical operation.

(*d*) For metritis and endometritis, bromide of potash, ergot, hydrastis, chlorate of potash, mercury, and iodide of potash may be given internally. Locally, hot antiseptic douches and glycerine and ichthyol tampons are of service. In bad cases the uterus should be curetted, swabbed out with iodised phenol, and packed with iodoform gauze. If there be inflammation of the ovaries or tubes, a similar course of treatment is called for, except that curetting in such cases is risky and apt to light up a general peritonitis. If there be evidence of pus, operation is called for, either for the evacuation of the abscess or the removal of the diseased appendages.

(*e*) If the uterus be displaced it should be replaced, and a suitable pessary adjusted.

(*f*) If there be a tumour of the uterus or ovary it should, if possible, be removed by operation, the extent of the operation varying with the nature, site, and size of the new growth.

3. *The Arrest of the Hæmorrhage.*—(*a*) I have already spoken of the importance of absolute rest in bed. In bad cases the foot of the bed should be raised to diminish the blood pressure in the pelvis.

(*b*) Prolonged hot vaginal douches are of great service in checking uterine hæmorrhage. They should be given as hot as can be borne, from 115° to 120° F., and frequently repeated. They are of special service in inflammatory cases.

(*c*) Curetting the uterus, swabbing it out with some antiseptic styptic, such as iodised phenol, and packing it with iodoform gauze is of great value, especially in cases of endometritis and subinvolution; or styptics may be applied to the interior of the uterus with Playfair's probes without a preliminary curetting.

(*d*) Packing the cervix with iodoform gauze and the vagina with cotton wool plugs is sometimes called for in emergencies, as in the floodings of placenta prævia and uterine cancer. It is a valuable temporary expedient giving the patient time to rally from a state of collapse and the surgeon time to make his arrangements for a more radical operation.

(*e*) Certain drugs may be administered internally in order to check uterine hæmorrhage. Of these, by far the most useful are ergot and hydrastis canadensis. Ergot, given by the mouth or hypodermically, causes powerful contraction of the muscular fibres of the uterus and of the arterioles. It is frequently given combined with other drugs, such as hydrastis, bromide of potash, strychnine, and chlorate of potash. It is of most value in the hæmorrhage of pregnancy and the puerperium, in subinvolution, and endometritis, and myoma. It is useless in cases of cancer. Hydrastis canadensis seems to act as an astringent to the congested endometrium. Cannabis indica is occasionally useful, but is rather uncertain in its action. A useful combination is the combination, in pill or tabloid form, of ergotin, hydrastinin, and cannabin.

Amongst other uterine astringents, given internally, may be mentioned hamamelis, sulphuric acid, and strychnine.

(*f*) Styptics may be applied locally on tampons of wool or Playfair's probes. The most useful of these are tannic acid, perchloride of iron, alum, iodine, chromic acid, nitric acid, and turpentine. In some cases, as inoperable epithelioma of the cervix, the application of the actual cautery (Paquelin's cautery at a dull, reddish-black heat) is of great service.

(*g*) Chloride of calcium has the power of increasing the coagulability of the blood, and may be given internally (in doses of ten to twenty grains) or applied locally with this object.

(*h*) Electricity, in the form of the constant current, may be applied to the interior of the uterus in cases of myoma, endometritis, and subinvolution. It is, however, an unsatisfactory remedy and sometimes does more harm than good.

(*i*) When all other measures fail, it may be necessary to remove the appendages, or to perform hysterectomy in order to stop uncontrollable uterine hæmorrhage. These measures are indicated in severe organic disease of the uterus and appendages, but in other cases should only be performed as the last resource.

V. DYSMENORRHŒA

Dysmenorrhœa, or painful menstruation, is perhaps the commonest condition the gynæcologist is called upon to treat. It must be borne in mind that it is a symptom of many diseases, but not a disease in itself. In perfectly normal menstruation there is no pain; but amongst civilised women, at any rate, the process is generally accompanied by some degree of discomfort. In most cases, however, this is quite bearable, and does not amount to more than a feeling of malaise, with some backache and a sense of fulness in the pelvis. Between such mild cases, and those where the women suffer the most horrible agony, there are infinite gradations. We cannot measure pain; and in some of the milder cases, it is difficult to say if the suffering the patient complains of be really in excess of what is usual in the average healthy woman—whether, in fact, it amounts to dysmenorrhœa. The personal factor must also be taken into account. The farmer's wife—a fat, phlegmatic woman, who has lived a wholesome life, and has no nonsense about her—seems to suffer little and makes no complaint; whilst the pampered invalid, thin, anæmic, and neurotic, writhes in agony. And yet the real amount of pain may be the same in both women; but the discomfort of the one is the anguish of the other. If the pain of menstruation be severe enough to interfere with the work of a poor woman, or the pleasure of a rich woman, it may be called "dysmenorrhœa." The character of the pain varies greatly. It may be only a dull backache, or an unpleasant sense of fulness in the pelvis. It may be sharp and lancinating, or of a heavy throbbing character, or griping, colicky, labour-like. It may be so severe that the patient rolls about the bed in torture. The pain is usually felt in the pelvis, just above the pubes, in the ovarian regions, and in the sacral region. In some cases it affects the loins and groins and shoots down the thighs.

It may begin a few days before the flow and be relieved by its onset; or it may commence with the flow and last either the first day or two, or the whole period. Some patients complain of constant pelvic pain during the intermenstrual interval, with a marked aggravation at each period.

It may date from the onset of puberty and last until the first pregnancy. In some cases it persists until the menopause. Or it may not appear till some time after puberty. In other cases it dates from an attack of pelvic inflammation, due to gonorrhœal infection or sepsis after parturition.

It is commoner amongst single than married women, and amongst the sterile than the fertile. It must not be thought, however, that dysmenorrhœa either causes or is caused by sterility: both are the result of some primary pelvic lesion, such as stenosis of the cervix, endometritis or salpingitis.

THE CAUSE OF THE PAIN.—Let us now briefly analyse the pain of dysmenorrhœa and consider the mechanism of its production. We may distinguish three main factors—(1) congestion; (2) spasm; (3) neuralgia.

1. *Congestion.*—If the blood pressure in an inflamed, hypersensitive, and resistant tissue be increased, pain is produced. A very slight increase of the blood-supply to a whitlow makes all the difference between comfort and misery. An inflamed tissue is very sensitive to alterations of tension; an attempt to stretch it causes agony, as is shown in the condition of "chordee."

Now, in chronic metritis and endometritis, the walls of the uterus become thickened, hard, and inelastic. When the menstrual engorgement takes place they cannot distend and accommodate the extra quantity of blood, and hence increased tissue tension results. This tension is interpreted by the hypersensitive uterine nerves—often themselves chronically inflamed—as pain.

There is some reason to believe that the ovaries and Fallopian tubes become engorged with blood some days before the onset of menstruation. If they be in an inflamed condition, and bound down by adhesions, their tissues cannot expand to accommodate the increased blood supply, and tension and pain result. In such cases the pain is premenstrual because the engorgement is premenstrual. The pain of congestion is dull, heavy, bearing-down, and throbbing in character. It is felt deep in the pelvis and in the sacral region.

2. *Spasm.*—The uterus is a mass of non-striped muscular fibres woven around a core of mucous membrane. These fibres are in a state of rhythmical activity, alternately contracting and relaxing. These rhythmical contractions are very evident in the pregnant uterus: they constitute one of the most reliable signs of pregnancy; and they are still more obvious in the pains of labour. Similar, but much feebler waves of contraction pass over the non-pregnant uterus. During menstruation they become more marked. Under certain morbid conditions these contractions become irregular, excessive, and painful. "Spasmodic dysmenorrhœa" is colic of the uterus. It is frequently associated with hyperæsthesia of the endometrium, particularly of the region of the internal os; and it is easily excited by the pressure in the cavity of the uterus of foreign bodies, such as pieces of exfoliated mucous membrane and blood clots.

In some of the cases of the extra-uterine dysmenorrhœa, it is probable that the colicky pains which precede each period are due to violent contractions of the muscular coats of the distended Fallopian tubes.

The pain of spasm is twisting, griping, colicky, or labour-like in character. It comes and goes rhythmically, and is generally complained of just above the pubes.

3. *Neuralgia.*—Both the uterus and the ovary may be the seat of neuralgia, especially in anæmic, neurotic women. In some cases it seems to be due to gout and rheumatism. There may be a hyperæsthetic condition of the endometrium, but usually the uterus is otherwise normal. In some cases of ovarian neuralgia the ovaries may be prolapsed, enlarged, and tender; but they are rarely grossly diseased.

The pain of neuralgia is burning, shooting, and lancinating, and is characterised by its wide distribution. It is felt not only in the pelvis and back, but also in the breasts, groins, and thighs.

THE VARIETIES OF DYSMENORRHŒA.—Much confusion has arisen from the perplexing system of classification adopted in the text-books.

Thus the following are described as distinct varieties of dysmenorrhœa—the congestive, obstructive, spasmodic, neuralgic, membranous, gouty, rheumatic, tubal, and ovarian forms. But we often find associated in the same patient the pain of spasm, the pain of congestion, and the pain of neuralgia. The tubal form may be both spasmodic and congestive, and the ovarian neuralgic and congestive. The absurdity of such a cross classfication is obvious.

Whilst we recognize as the immediate causes of the pain the three factors of spasm, congestion, and neuralgia, it is convenient to classify cases of dysmenorrhœa as follows:—

1. Those due to *local* (pelvic) causes—(*a*) uterine; (*b*) extra-uterine.
2. Those due to *general* systemic causes.

UTERINE CAUSES.—(1) *Arrested Development of the Whole Uterus.*—In some cases the uterus is small and imperfectly developed. In extreme cases it remains in the infantile condition. Puberty is delayed; and when the periods do appear they are irregular, occuring at long intervals, short in duration, scanty, and very painful. The pain seems to be due to the inability of the uterus to expand and accommodate the increased blood-supply.

(2) *Stenosis of the Cervix.*—Here the body of the uterus is normally developed, but the cervix remains small and tapering, with a pin-hole os. A condition of stenosis of the cervix may be acquired years after puberty as a result of cicatricial contraction after injudicious operations on the cervix or the application of caustics. The narrow lumen offers a real obstruction to the menstrual flow, particularly if the latter contains clots or pieces of exfoliated mucous membrane. Violent spasmodic contractions of the body of the uterus are then set up in order to overcome the obstruction. There is frequently superadded more or less endometritis. Hence in these cases the dysmenorrhœa is usually both spasmodic and congestive.

(3) *Metritis and Endometritis.*—These are very common causes of dysmenorrhœa, the pain being due to congestion causing painful tension in the rigid diseased tissues of the uterus. In many cases of endometritis the mucosa exfoliates in distinct membranous flakes. The menstrual discharge is frequently clotted. These clots and fragments of membrane act as foreign bodies and excite uterine spasms.

The so-called membranous dysmenorrhœa is due to a peculiar form of endometritis in which the whole mucosa exfoliates *en masse*, and is passed as a complete cast of the endometrium. This cast resembles a small decidua. It is a triangular sac, with a smooth interior and a rough exterior. Examined microscopically, it is seen to consist of the abnormally-thickened endometrium with gland follicles, connective tissue, stroma, and blood-vessels. Some authorities look upon it as a very early abortion with a blighted ovum. But this is probably an erroneous view, as, though almost peculiar to married women, it has been met with in chaste single women. Moreover, it contains no trace of chorionic villi. The membrane may be passed every month, or at intervals of two, three, or four months—the intervening periods being normal. The membrane is expelled on the second or third day of the period, its expulsion being preceded by violent uterine spasms, resembling the pains of labour. After the membrane is discharged the pains cease and the period procedes normally.

(4) *Tumours of the Uterus.*—Myomata (especially the interstitial, submucous, and polypoid) may cause painful menstruation, both by exciting colicky contractions of the uterus and by giving rise to extreme congestion of the organ. The marked menstrual turgescence causes the myomata to swell at each period, and hence pressure symptoms are always worse at these times.

Extra-uterine Causes.—(1) *Ovarian Disease.*—Any inflammation or degenerative condition of the ovaries may cause dysmenorrhœa. There may be acute or chronic oöphoritis, cystic degeneration, or sclerosis. There may be merely a big, tender, prolapsed ovary, or the ovaries may be bound down by chronic adhesions. As a rule, big ovarian cysts do not cause dysmenorrhœa unless there be pelvic adhesions.

(2) *Tubal Disease.*—The Fallopian tubes may be in a state of acute or chronic salpingitis, hydrosalpinx, pyosalpinx, or hæmato-salpinx. They may be bound down by dense adhesions.

(3) *Pelvic Peritonitis and Cellulitis.*—The uterus, ovaries, and tubes may all be bound down and matted together by dense peritonitic adhesions, or from chronic cellulitis the uterus may be dragged to one or other side of the

pelvis; or, if there be utero-sacral cellulitis, drawn backwards and acutely anteflexed (pathological anteflexion).

In most cases of inflammation in the appendages we find a compound lesion, viz. oöphoritis, salpingitis, and pelvic peritonitis co-existing.

These extra-uterine causes of dysmenorrhœa usually give rise to marked premenstrual pain. This pain is due partly to premenstrual congestion of the inflamed adherent organs and partly to colicky contractions of the distended Fallopian tubes. Hence the patient's sufferings are acute during the week preceding the period, and are, as a rule, greatly relieved by the onset of the flow. In many cases, however, there is also more or less endometritis, and from this cause the pain may last throughout the whole period.

General Systemic Causes.—There are some cases of dysmenorrhœa without any tangible sign of pelvic disease. Here we look for the cause in the disordered state of the patient's blood or in an abnormal condition of her nervous system. Thus in anæmia, gout, rheumatism, on the one hand, and hysteria and neuræsthenia on the other, there is not infrequently painful menstruation of a neuralgic type.

Treatment.—There are three main lines of treatment to be followed:— 1. Improve the general health. 2. Relieve pain. 3. Treat any pelvic lesion.

1. *The Care of the General Health.*—The general hygienic surroundings of the patient must be inquired into and, if defective, remedied. Any unhealthy occupation must be given up and the patient made to live in as pure an atmosphere as possible. A change of air, as to the seaside or the country, is often advisable. The diet should be simple, easily digested, and non-stimulating. Alcohol, spices, strong tea, and coffee should be avoided. The patient should be amply clad, wear warm woollen under-garments and avoid tight-lacing. The bowels must be attended to, and if there be any tendency to constipation it must be remedied by laxative food, saline aperients, cascara, or compound liquorice powder. During the period she should rest either in bed or on the sofa. During the inter-menstrual interval—unless there be serious pelvic disease—she should be encouraged to take plenty of active exercise in the fresh air. Walking, riding, cycling, rowing are all good in moderation. But there must be no over-fatigue, no violent strain, no "scorching" or cycling up stiff hills. The modern girl's taste for athletics is to be encouraged, as, if not carried to excess, it tends to prevent anæmia, constipation, dyspepsia, and hysteria, developing a healthy mind in a healthy body. Anything that tends to promote vicious habits of thought and morbid excitement must be guarded against. She should avoid the giddy whirl of fashionable society, with its artificial life, its late hours, its unwholesome dinners and suppers, its crowded "at homes," concerts, and balls. By such simple remedies as fresh air, rational clothing, wholesome food, judicious exercise, attention to the bowels, and healthy moral influences, many a case of neuralgic dysmenorrhœa may be cured.

In other cases, however, there are constitutional disorders, which call for active medicinal treatment. If she be anæmic, iron and arsenic must be given; if gouty, alkalies, iodide of potash and colchicum; if rheumatic, guaiacum, sulphur, and salicylate of soda. If she be hysterical, sedatives, such as bromide of potash, valerian, castoreum, and asafœtida may be needed. If neurasthenic, nervine tonics such as strychnine, phosphorus, quinine, and damiana are indicated, whilst in severe cases the "Weir-Mitchell treatment" is of great value.

2. *The Relief of the Pain.*—(1) Rest.—In every case of severe dysmenorrhœa the patient should, if possible, spend the whole of the period in bed.

The recumbent posture lessens the pressure in the pelvic blood-vessels and mechanically relieves the pelvic congestion. The foot of the bed should be raised in order to further elevate the pelvis and so promote the flow of blood out of it.

(2) Heat.—Heat applied in various ways often gives wonderful relief. In some cases a hot mustard poultice applied to the abdomen acts like a charm. Dry heat may be applied by means of Leiter's metallic coils, or the ordinary domestic india-rubber hot-water bottles or salt bags. A hot bath lessens the blood pressure in the pelvis by dilating the capillaries of the skin. Hot vaginal douches are of great service, given as hot as the patient can bear (105°-115° F.), both during the period and the inter-menstrual intervals—especially in those cases of dysmenorrhœa due to inflammation of the uterus or the appendages. Copious hot drinks—not alcoholic—such as hot milk, hot ginger and water, hot peppermint and water, etc., are of service in promoting cutaneous dilatation and so lessening pelvic congestion.

(3) Anodyne Drugs.—What medicines may we give to directly relieve the patient's sufferings? There are two remedies that must *not* be given, alcohol and opium; and this in spite of the fact that we know of nothing that will relieve the pain so promptly or so effectually. A stiff glass of hot gin and water, given at the commencement of the period seldom fails to bring ease and comfort and tide the patient over the agony of onset. Could we only be sure that the single tumbler of toddy once a month would never be exceeded, the remedy would be an excellent one. But a sad experience teaches otherwise, for there can be no doubt that much of the secret drinking that prevails amongst women is the result of the pernicious practice of plying them with alcohol during their monthly periods.

So also with opiates: a hypodermic injection of $\frac{1}{4}$ to $\frac{1}{2}$ grain of morphia will almost certainly give immediate relief to the patient's suffering. But the danger of teaching her the seductive morphia habit is so great that only in exceptional cases are we justified in administering it. Dysmenorrhœa is a lesser evil than morphia mania. In neuralgic cases, such coal-tar derivatives as antipyrin, phenacetine, exalgine, acetanilid, ammonol, frequently give relief. It is advisable to give them with a cardiac stimulant such as sal volatile or caffein, to prevent the depressing influence these drugs sometimes exert on the heart. In spasmodic pains due to uterine colic, belladonna and cannabis indica are very efficacious. They must be given in large doses and pushed until they begin to exert their full physiological effects.

The nitrites (such as nitrite of amyl and nitro-glycerine) occasionally are of service in relieving uterine spasm and lessening pelvic engorgement by dilating the superficial arterioles. Pulsatilla and caulophyllum frequently give great relief in spasmodic dysmenorrhœa, especially where the flow is scanty. Viburnum opulus and viburnum prunifolium are most valuable anti-spasmodics and uterine sedatives. They are of most service in uterine colic and of least value in the neuralgic cases. They are nauseous drugs and are best given in capsules. In most cases of pelvic congestion bromide of potash, in thirty-grain doses (combined with belladonna if there be uterine spasm, or with antipyrin if there be neuralgic pain) is of great service.

3. *The Treatment of the Pelvic Lesion.*—Obviously, if dysmenorrhœa be due to disease of the pelvic viscera, the most certain method of relieving the pain is to remove the causative lesion. This, however, is not always advisable or justifiable, as it may involve an operation which not only risks the

patient's life, but irretrievably mutilates her and deprives her of all possibility of having children. The cure may, in fact, be worse than the disease. An operation is only to be recommended in cases where milder measures have been tried and failed, and where the patient's sufferings are intolerable.

(1) In the Infantile Uterus.—If this condition exists in a marked degree, it is incurable, and nothing short of removal of the uterine appendages or, what is preferable, vaginal hysterectomy, will relieve the patient's sufferings. In the milder degrees, tonics, especially iron, should be given, and the patient encouraged to marry. Many of these cases are cured by marriage, which arouses the uterus into increased nutritive activity and improves its circulation. As the uterus develops, the periods become more regular, less scanty and less painful. Should conception occur, the cure becomes complete. It must, however, be remembered that many of these cases are sterile. Electricity and dilating the cervix by the insertion of an intra-uterine stem pessary are sometimes advised in these cases, but they are rarely of much use and may do harm.

(2) Stenosis of the Cervix.—Here dilating the cervix is of great value and nearly always effects a cure. The best results are obtained in the purely spasmodic cases, particularly where spasm is excited by the passage of a bougie through the internal os. Dilatation is contra-indicated if the uterus be fixed by peri-uterine adhesions and is a highly dangerous proceeding if there be inflammatory disease of the uterine appendages. The best time for its performance is midway between two periods. It should be done under an anæsthetic and with scrupulous aseptic precautions. The canal is best dilated with graduated metal dilators. It should be done slowly and without using undue force, otherwise the uterus may be perforated or ruptured. After full dilatation, the cavity of the uterus should be packed with iodoform gauze. This should be removed at the end of forty-eight hours, and thereafter the vagina irrigated night and morning with some mild antiseptic. To prevent recontraction it is sometimes advisable to insert a glass intra-uterine stem pessary which the patient should wear for a couple of months.

Frequently a single dilatation effects an immediate and permanent cure. In some cases the relief is only temporary; after a few months of ease, the old pain begins to return. In such cases it is advisable to repeat the dilatation. Sometimes the operation does no good whatsoever. In the case of young married sterile women the stenosis of the cervix causes not only dysmenorrhœa, but also sterility. Here the dilatation often cures the sterility as well as the pain at the periods. Moreover, the occurrence of pregnancy is much to be desired, as it effectually and permanently cures the stenosis.

(3) Metritis and Endometritis.—Before resorting to operative measures, an endeavour should be made to remove the chronic inflammation by "antiphlogistic" remedies. The patient must rest in bed, have frequent hot vaginal douches, and every night have inserted a glycerine and ichthyol vaginal tampon. She must keep her bowels open with saline aperients. Medicinally, a mixture containing chlorate of potash should be given, combined with ergot if there be menorrhagia, and with iron if there be anæmia and debility. If there be any suspicion of syphilitic or gonorrhœal infection, mercury and iodide of potash will work wonders.

If, in spite of these measures, the disease continues—particularly if it be endometritis—the operation of curetting is called for. After thoroughly scraping away the endometrium, the uterus should be swabbed out with iodised phenol and packed with iodoform gauze for forty-eight hours. After removing this gauze, the vagina is to be irrigated with some mild antiseptic and the patient kept in bed till after the next period.

(4) Tumours of the Uterus.—If there be a polypus or submucous myoma, these should be removed by operation.

If there be an interstitial myoma, the patient should be kept at rest; given hot douches; and, internally, ergot, hydrastis, and bromide administered. Should this line of treatment fail, and the patient be both in pain and flooding severely, the tumour should be removed either by enucleation or by total extirpation of the uterus.

(5) Ovarian Disease, (6) Tubal Disease, and (7) Chronic Pelvic Peritonitis.—In the case of ovarian tumours, there should be no delay in removing them by operation. In the case of acute and chronic pelvic peritonitis, oöphoritis, and salpingitis, antiphlogistic treatment should be carried out; mercury and iodide of potash, bromide of potash, or salix nigra given; hot vaginal douches and ichthyol-glycerine tampons administered; and the patient kept at rest. If the appendages be bound down by adhesions and the ovaries cystic, the abdomen should be opened, the adhesions separated, and the cystic part of the ovary resected. If the ovaries and tubes be grossly diseased it may be necessary to completely extirpate them. This should only be done as the *dernier ressort.* It must never be undertaken lightly, nor without frankly explaining to the patient the immediate and remote results. It is not equally efficacious in all cases of dysmenorrhœa. As a general rule, the less there is the matter with the appendages, the less likely is their removal likely to cure the dysmenorrhœa. For instance, the complete removal of both ovaries and tubes rarely fails to relieve the suffering due to pyosalpinx or abscess of the ovaries. But it is often of little or no use in those cases which are doubtfully labelled "chronic oöphoritis." It certainly in most of such cases arrests the menstrual flow; but it often fails to relieve and may even aggravate the chronic pelvic pain, the groin-ache, the backache, and the nervous depression from which she suffers. To remove healthy ovaries and tubes to cure a dysmenorrhœa for which there is no local cause, is as barbarous as the wholesale extracting of healthy teeth to remedy a facial neuralgia. It is absolutely unjustifiable unless the patient's sufferings be such as to render life unendurable and all milder measures have failed. In such cases, moreover, the operation of vaginal hysterectomy is safer, more certain of relieving the patient, and less likely to be followed by untoward after-results than the removal of the ovaries.

Intermenstrual Pain or "Mittelschmerz."—This rare condition was first described by Priestley. It is characterised by marked pelvic pain, occurring not at or just before the period, but midway between two periods. It is regular in its onset—always fourteen days before the next period. The pain is violent and occurs in paroxysms, and lasts for three or four days. It is sometimes accompanied by a watery discharge from the uterus. In a few instances the discharge is hæmorrhagic, but scanty, so that there is an abortive period in the middle of each interval. On examination, the pelvic organs may be found quite normal, but usually distinct signs of chronic inflammation are found in the tubes or ovaries. In a considerable number of cases the condition of hydrosalpinx has been found associated with "Mittelschmerz," and by most authorities is believed to be the cause.

The treatment is that of dysmenorrhœa. If there be evidence of diseased tubes or ovaries these organs must be treated *secundum artem.* In intractable cases, where there is severe suffering, the uterine appendages may have to be extirpated.

RETENTION OF THE MENSES

Retention of the menses is a rare condition—as rare, indeed, as suppression of the menses (amenorrhœa) is common. In suppression there is an arrest of secretion; in retention, the menstrual fluid is poured out, but from occlusion, or "atresia" of part of the genital canal, is dammed up above the point of obstruction and collects within the body.

If the duct of a secreting gland be occluded, the secretion collects in the cavity of the gland, and distends it into a retention cyst. Thus if the ureter be blocked by a calculus, the renal secretion distends the kidney into a cystic tumour—a hydronephrosis. Should this collection become infected with pyogenic micro-organisms suppuration occurs, and the kidney becomes a bag of pus—a pyonephrosis.

By precisely similar processes, if the cervix be occluded and the outflow from the uterus prevented, the organ becomes converted into a huge retention cyst. If the contents be merely menstrual blood, the condition is that of hæmatometra. If micro-organisms gain access to the retained secretion decomposition occurs, the fluid becomes purulent, and a pyometra is produced.

Atresia of the genital canal may be either acquired or congenital, and it may occur (*a*) at the hymen, (*b*) in the vagina, (*c*) in the cervix.

Acquired atresia usually occurs in the cervix, and is the result of some preceding operation or inflammatory lesion, causing destruction of tissue and cicatricial contraction. Thus a patient has an epithelioma of the cervix removed by means of Paquelin's cautery. This causes extensive sloughing and suppuration, and, finally, in place of the cervical canal there is left a dense mass of scar tissue. This completely seals up the mouth of the womb, which then becomes distended with menstrual blood (hæmatometra).

The causes of acquired atresia of the *cervix* are:—

(*a*) Operations on the cervix, such as amputation.
(*b*) Endocervicitis.
(*c*) The application of caustics to the cervix.
(*d*) Sloughing after parturition.

The causes of acquired atresia of the *vagina* are:—

(*a*) Injuries causing sloughing, severe burns, caustics.
(*b*) Severe vaginitis.
(*c*) Syphilitic ulceration.
(*d*) Sloughing after parturition.

Congenital atresia is caused by some arrest of the process by which the uterus, Fallopian tubes, and vagina are developed. It will be remembered that these organs are formed from the two Müllerian ducts. These ducts, in early fœtal life, are two solid parallel columns of cells. They next become hollowed out into two parallel tubes. Later still these tubes fuse in their posterior and middle thirds to form a single tube (the vagina and uterus), whilst the anterior thirds remain separate and form the Fallopian tubes. The ostium vaginæ (and hymeneal orifice) is formed by an invagination from the skin opening into the lower end of the fused Müllerian ducts. Should there be any arrest in the process of hollowing out the solid columns of cells into the ducts a horizontal septum is formed, completely closing the vaginal or uterine canal, and causing atresia. As soon as the age of puberty arrives, the menstrual blood begins to collect above the point of obstruction and the utero-vaginal canal becomes a retention cyst.

On the other hand, should there be any interference with the process of fusion of the ducts of Müller, a degree of doubling of the uterus (or vagina) is produced. The two conditions, viz. retention of the menses and doubling of the uterus, frequently coexist.

In order to illustrate the sequence of events let us suppose that in the lower third of the vagina there is a congenital atresia. At puberty, and at each period after, the uterus pours out some three or four ounces of blood. This collects in the vagina above the atresia and distends it into a large cystic swelling, which fills the pelvis and rises up into the abdomen as an oval tumour. The uterus is lifted up by this mass, and at first is not distended, as its walls are much thicker and more resistant than those of the lax, elastic vagina. Later, as the pressure increases, the uterus also becomes distended, and may form a mass as big as the womb six months pregnant. Still later the fluid distends the Fallopian tubes, until they become huge sausage-shaped masses on either side of the fundus. Lastly, the retained menstrual secretion may burst the Fallopian tubes, pour into the peritoneal cavity, and give rise, if aseptic, to an intra-peritoneal hæmatocele; if septic, to an acute peritonitis.

When the retention cyst is formed by the vagina it is called a "hæmatocolpos" if the fluid be blood, and a "pyocolpos" if it be purulent. Similarly, when formed by the uterus it is termed a hæmatometra or pyometra. When the Fallopian tubes are distended with blood the condition is termed hæmatosalpinx; when with pus, pyosalpinx.

In many cases there is more or less doubling of the genital canal. The uterus may be bicornuous, septate, or double. The vagina also may be divided by a mesial septum into two distinct tubes. Occasionally in these cases the atresia affects one side only, there being menstrual retention on that side, whilst on the other the menses are discharged normally.

The retained blood is characteristic in appearance. It is a thick, dark chocolate-brown, treacly fluid, very viscid from the presence of mucus. Under the microscope it is seen to consist of broken-down blood corpuscles, altered blood pigment, and epithelial cells.

Symptoms and Signs of Congenital Atresia with Retention.—Until the age of puberty there are no symptoms. Then it is noticed that though the girl each month has pelvic pains there is no external flow of blood. With each monthly epoch the pain increases and becomes colicky in character. On examination there is found rising out of the pelvis, and filling part of the lower abdomen, a tense oval swelling, elastic or fluctuating, and feeling not unlike the pregnant uterus. It contracts intermittently, and on auscultation a bruit may be heard over the sides of the mass. If the Fallopian tubes be affected they may be felt as two rounded or sausage-shaped masses on either side of the larger central tumour. The vulva may be normal, or through it the bulging imperforate hymen may be found. If the atresia be in the vagina the bladder and rectum may be felt in contact below, whilst on rectal examination the lower pole of the distended vagina or uterus may be felt. If the fluid be purulent, then, in addition, there will be septic symptoms, rigors, high temperature, quick pulse, emaciation, and local tenderness. In those cases of double uterus, where one-half is patent and the other half occluded and distended with blood, the symptoms are somewhat different. Menstruation is present, but at each month there is severe colicky pain on the occluded side. On examination, to one side of the uterus (and sometimes also of the vagina) a lateral cystic swelling may be found.

Treatment.—Whenever possible an attempt should be made to reach the collection per vaginam, and by this route to evacuate the retained secretion. After careful disinfection of the vulva and vaginal cul-de-sac, a horizontal incision should be made in the roof of the cul-de-sac, or through the unperforate hymen, and deepened by dissecting up between the bladder and rectum if they be in contact. When the wall of the retention cyst (vagina or uterus) is reached it should be opened transversely and, if possible, drawn down and sutured to the mucous membrane of the cul-de-sac. The viscid retained secretion should be washed away by prolonged irrigation with some mild antiseptic (such as boracic solution) and the cavity lightly packed with iodoform gauze. If the Fallopian tubes be not distended nothing further is required. But should they be felt as big, sausage-shaped masses on either side of the uterus, the abdomen should be opened, and the tubes emptied of their contents or removed altogether.

In a certain number of cases the surgeon will fail to reach the retention cyst from below. Here he must open the abdomen and extirpate the distended organs. In cases where there is doubling of the vagina, or a septate condition of the uterus, the surgeon should divide the septum and throw the two cavities into one. In all cases where an artificial opening is made, either in the vagina or cervix, there is a tendency for it to reclose by slow cicatricial contraction. This tendency must be counteracted by the wearing for months or years of a flanged vulcanite or rubber tube.

The great danger of all operations for retained menses is septic infection, which can only be prevented by the most scrupulous antiseptic precautions.

Prognosis.—The gravity of the case depends on the situation of the atresia, and the extent to which the upper portions of the genital canal have become involved. Thus atresia of the cervix is more serious than hymeneal atresia, and hæmatosalpinx and hæmatometra are graver lesions than hæmatocolpos. Obviously, too, if suppurative changes have occurred the prognosis is still more grave. It follows, therefore, that there should be no delay in operating, and every endeavour must be made by rigid aseptic precautions to prevent infection.

Mental Deficiency.

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(*See also* "Mind" and "Physiognomy.")

Definition.—Under this comprehensive term we propose to include the varying grades of defect of mental development, as distinguished from mental breakdown, designated (in order of their severity) feeble-mindedness, imbecility, and idiocy. The defect, though not of necessity congenital, always depends upon causes acting early in life prior to the complete evolution of the faculties, and in this way is differentiated from insanity. In many cases, indeed, there exists an innate predisposition to mental abnormality, due to inherited nervous instability, though actual defect may not show itself till some critical epoch of development (*e.g.* the period of dentition or of puberty). Where predisposition exists, moreover, injury may act in an altogether disproportionate degree in producing mental defect to that which would obtain in a child of normal heredity, so that a fall which would leave unscathed the mental condition of the latter may, in the former case, lead to impaired mental development.

CLASSIFICATION.—According to the period at which mental deficiency manifests itself we may classify all cases into three main groups, viz.:—

I. CONGENITAL.
II. DEVELOPMENTAL.
III. ACCIDENTAL (OR ACQUIRED).

I. CONGENITAL cases may be subdivided into several distinct types, each with characteristic physical features, mental peculiarities, and (as we shall see more fully when considering the etiology of the subject) causative factors. The leading types may be stated as follows:—

(*a*) *Microcephalic* cases.
(*b*) *Porencephalic* cases.
(*c*) *Hydrocephalic* cases.
(*d*) *Mongoloid* cases.
(*e*) *Cretinoid* cases.
(*f*) *Primarily neurotic* cases.

(Other cases, such as those connected with birth palsies or the early manifestations of syphilis (inherited) or of scrofula, might almost be called congenital, but in this article we shall consider the former as an *accidental* form and the latter as *developmental.*)

(*a*) *Microcephalic* cases are, of course, distinguished by smallness of head, and it has been proposed by some authors to limit the term microcephalus to heads the circumference of which does not exceed seventeen inches. The abnormality is, however, not exclusively one of size, as thus ascertained: it is rather one of formation. Microcephalic heads have a characteristic form. The forehead, deficient in lateral development, rapidly recedes to a somewhat pointed vertex (*oxycephalic*), and the occipital region is flattened. Such cranial characters, together with large bright eyes and a prominent nose, may often be discerned in cases of but slight mental impairment (the so-called *feeble-minded*), even when circumferential measurements are not much below the normal, and may indeed furnish a key to the mental inferiority manifested. Extreme cases, in which the greatest circumference did not exceed thirteen or fourteen inches, have been from time to time recorded under such titles as the "bird-man," the "ape-man," the "rabbit-man," etc., and the so-called "Aztecs" formerly exhibited in Barnum's show, whose cranial circumference was under fifteen inches, belonged to this type. With a capacity of less than 400 grammes, which obtains in such instances as the above, the manifestations of mind must necessarily be of the simplest. But as the capacity increases it is surprising how human mental characteristics assert themselves, and in a case formerly under the daily observation of the present writer, in which the weight of the encephalon was no more than 352·5 grammes (the circumference of head being little over fifteen inches), there was some power of speech and of reasoning out ideas (2). Indeed, it may be said that with this type the gradations of intelligence vary very much with the size of the brain.

Certain *atrophic* conditions of portions of the brain may be mentioned in connection with this type, such as defects of the corpus callosum and other commissural structures which have been recorded by Langdon-Down, Bruce, and others. A remarkable case of cerebellar atrophy in an imbecile girl of fifteen, who presented no ataxic symptoms during life, was observed by the present writer.

(*b*) *Porencephalic* cases, usually associated with paralytic idiocy, have been described by Heschl, Micrzejewski, Kundrat, Wiglesworth, Shuttleworth, and others. True porencephalus may correctly be described as a congenital condition, inasmuch as it usually dates from the fifth to the seventh month of intra-uterine life. (There is also an acquired or false porencephalus, resulting from destructive lesion after birth.) However caused, the brain is deformed by a communication between the surface of the hemisphere and the lateral ventricles. In some cases, as in one met with by the writer, asymmetry of the skull may result with a flattening of the corresponding frontal region; and in all, hemiplegic symptoms result.

(*c*) *Hydrocephalic* cases may be of antenatal origin, but more frequently hydrocephalus comes on after birth, either in early infancy or at the period of dentition. Cranial deformity varies much in extent according to the amount of effusion, though cases are recorded—of the congenital type especially—in which the volume of the brain has been diminished by the pressure of fluid without much expansion of the bones of the skull. As a general rule, however, the obovate appearance of the head viewed from above, its globular aspect when looked at from in front, with bulging at the temples, and eyeballs with depressed axes, are characteristic of this type. The enlargement of the skull sometimes takes place in the antero-posterior direction, constituting the *scaphocephalic* form described by Bourneville. The degree of mental impairment varies remarkably in hydrocephalic cases, not always in direct ratio to the excessive size of head, which may vary from 22 or 23 inches to 37 in circumference, an extreme case being described by Séguin of the latter dimensions, in which there was a fair amount of mental activity.

(*d*) *Mongoloid* cases have very definite physical characteristics, accompanied with mental traits which are also typical. The head is brachycephalic, with tendency to parallelism of anterior and posterior planes—that is to say, there is defective occipital development, with an absence of protuberance. The eyes are often obliquely set, with the palpebral fissures sloping upwards to the external angle. At the inner angle there are frequently found traces of an epicanthic fold prolonged from the upper eyelid. The nose is usually short and spread; the mouth open, disclosing a thick-tipped tongue, the surface of which is marked (in older children at any rate) with transverse furrows. The palate is often high and narrow. The hair is straight, wiry, and with no tendency to curl. The bones of the limbs are usually small, and the ligaments lax; the fingers thick and short, the little finger especially so, with incurvation towards the ring finger. The skin is, as a rule, coarse, sometimes furfuraceous, and often the lips are fissured. Walking and talking are always late, and the voice is gruff and guttural. Mimicry is the prominent mental characteristic, and there is often an appreciation of rhythm, both in movement and in music. Tubercular disease is the usual termination of this type of cases.

(*e*) *Cretinoid* cases (*sporadic cretins*) are perhaps, as a rule, hardly in the strict sense of the word congenital, for the symptoms denoting cretinism do not come into prominence until after the first few months of infancy. Still, the arrest of development of the thyroid gland, upon which cretinism is known to depend, points to an ante-natal originating cause, so as to justify this classification. The full development of the characteristic features of sporadic cretinism is, however, gradual, and in the early stages there is a certain resemblance to the mongoloid type above described. Like those cases, sporadic cases are brachycephalic, but the cretin's head is flatter on the top, and expanded more squarely than that of the mongol, and the hair is scanty as well as wiry. The nose of the former is broad, with extended nostrils, and the bridge being flattened, the space between the eyes seems large. There is no obliquity of the palpebral slits as in the mongol, but the lids are often suffuse and pendulous. The lips are thick and coarse, and the tongue protrudes, appearing too large for the mouth, though not marked by furrows like that of the mongol. The teeth are late in erupting, and decay early; the palate is usually expanded. There is often a flushed patch on the cheeks, and the skin generally is harsh, sometimes even icthyotic. The thyroid gland is not to be felt, but in the posterior triangles of the neck little fatty tumours may often be made out. The skin is baggy, apt to fall into folds about the neck, as if redundant; the abdomen protuberant, and not infrequently an umbilical hernia exists. The long bones are thickened and often bowed, and in some cases there is spinal curvature. The hands are spade-shaped, short and broad; and these and the clumsy-looking feet are slow and inapt in their proper movements. With these physical characteristics a common mental condition obtains, which may be summed up as one of slow reaction. Nerve currents take an appreciable time to filter through the myxœdematous tissues, with the result that both apprehension of ideas and response are retarded, and all action is of a sluggish character. The dawn of a smile in a cretinous child is a time-phenomenon interesting to study. Puberty rarely asserts itself in untreated cases; indeed, the sporadic cretin remains an infant for life, of diminutive size and undeveloped intelligence.

(*f*) Under the *primarily neurotic type* we include children born with unstable nervous systems, the result of a neurotic inheritance. The inherited neurosis may show itself in a variety of ways; nervous irritability, sleeplessness, night or day terrors, convulsions, being some of its morbid manifestations, whilst want of power of attention and of continuity of thought, sometimes moral obliquity, are amongst the mental abnormalities to which it gives rise. There is a certain sharpness of apprehension and spasmodic quickness of response with such children differentiating them from the types previously described, and the physical features are not so marked. A high and narrow, sometimes deformed, palate is found in the majority of these cases; but "nerve signs" are the essential characteristics of the type, such as frontal corrugation, finger twitches, and a peculiar attitude of the hands when extended, well described by Warner, as consisting of a drooping wrist, a contracted palm, arched on the top and hollow on the under surface, with thumb bent back, and each finger bent back at knucklebone.[1]

We have now made a general survey of the most common typical forms of congenital mental defect. It must not, however, be understood that every such case can be classified under one or other of these types; indeed, probably the majority of cases are of a mixed character, though sometimes the constituent factors may be discerned. Ireland has invented the term "*genetous* idiocy" to "comprehend cases whose pathology cannot be properly diagnosed until after death," and instances cases of inflammation of the brain occurring before birth, etc. For the miscellaneous cases above referred to the term may be convenient to distinguish those dating from birth from the forms of mental deficiency subsequently arising; otherwise it would seem that the types we have described are better classified under the better understood term *congenital*.

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[1] Warner, *Nervous System of the Child*, p. 55.

II. DEVELOPMENTAL cases might perhaps be described as a variety of the congenital in which the signs of mental deficiency are late in showing themselves. The tendency is indeed born with the child, and will usually assert itself to a large extent independently of circumstances, when the due period of development has arrived. This may vary considerably with different types; in some it occurs within a few weeks of birth, in others at the period of first or second dentition, in others, again, at the trying epoch of puberty. The several types may be arranged, as far as possible, in the order of manifestation of the mental defect, as follows:—

(*a*) *Amaurotic*.
(*b*) *Eclampsic*.
(*c*) *Epileptic*.
(*d*) *Syphilitic* (inherited), "*juvenile general paralysis*."

(*a*) Amaurotic is a convenient term to designate that variety of mental defect (idiocy) which has been described by Sachs and other American writers, and by Kingdon and Risien Russell in this country, under the title of "Infantile cerebral degeneration, with symmetrical changes at the macula" (7). Commencing in the early months of infant life by muscular enfeeblement associated with distinctive ophthalmoscopic appearances, it progresses to almost complete paralysis, and terminates in the death of the patient about the end of the second year. The child (generally of Jewish parentage) is born at the full term of gestation, and at birth does not appear to differ from an ordinary healthy child. Some weakness of back and neck, and a suspicion of imperfect sight, attract attention at the age of three months; and soon the child, previously lively, becomes apathetic, drops objects placed in its hands, and finally sees nothing, and takes little interest in its surroundings—sounds alone arousing it. Muscular atrophy and general emaciation follow till death closes the scene.

(*b*) *Eclampsic* cases form a large proportion of all cases of mental defect. About one-third of the idiotic and imbecile patients of the Royal Albert Asylum were said to have suffered from convulsions during teething; but the question, of course, arises how far these were the *efficient* cause of the mental condition. It is probable that in the majority the eclampsia was but one of the signs, though the most impressive one of the innate nervous instability inherited from parents, who, however, are usually slow to recognise an innate inherited tendency to defect. Be this as it may, there is no doubt that the frequent recurrence of fits in early life interferes with normal mental development, and even when the child's general health improves and the fits disappear—as is the case in the eclampsic as distinguished from the epileptic type—mental enfeeblement, ranging from mere feeble-mindedness to idiocy, is apt to supervene.

(*c*) *Epileptic* cases include those in which, in contradistinction to the eclampsic cases just described, there is no cessation of convulsive attacks after the period of dentition, or in which epilepsy may have come on after this period, but at so early an age as to interfere with the normal evolution of the child's faculties. Epilepsy at a later age is apt to produce mental deterioration, but in this case epileptic dementia (rather than amentia) is the more appropriate classification. From the practical point of view, cases of epilepsy occurring during the educational period may have to be considered together, and in an investigation of 350 cases (conducted by the writer for the London School Board) only about 17 per cent were found fit for the ordinary school curriculum, 27·5 requiring extra care in schools for special instruction, whilst 40 per cent were only fit for epileptic institutions, and 15·5 per cent were idiots and imbeciles. As a rule, the earlier the manifestation of the epilepsy the more serious the mental condition, such cases being for the most part due to hereditary neurosis.

(*d*) *Syphilitic* cases figure comparatively rarely amongst idiots and imbeciles, forming no more than 1·17 per cent of the 2380 cases investigated for etiological purposes by Beach and Shuttleworth, as judged by observed stigmata of inherited syphilis. It is probable, however, that it really forms a more considerable factor, especially in the minor forms of mental defect. In well-marked cases the ashy complexion, with radiating scars around mouth, and the existence, after second dentition, of notched Hutchinsonian "teeth," or of teeth of the peggy "corkscrew" type, are pathognomonic, especially when these evidences co-exist with traces of interstitial keratitis and a syphilitic parental history. Of late years Clouston and others have drawn attention to a class of degenerating cases, under the designation of *juvenile general paralysis*, which, according to the experience of the present writer, seem to be essentially of this type, and which were long ago described by Mendel, Judson Bury, and others as cases of syphilitic dementia occurring in children. As a rule the symptoms of mental deficiency do not manifest themselves till the onset of puberty, up to which the intelligence has been up to the average: progressive deterioration then sets in, the knowledge previously acquired being gradually lost, dementia and paresis finally leading to a fatal termination.

III. ACCIDENTAL (or ACQUIRED) cases include those cases of mental deficiency which cannot be traced to causes in operation prior to birth, but are reasonably attributed to accident, disease, mental shock, or it may be merely mal-nutrition, during the period of childhood. They may be divided into the following groups:—

(*a*) *Traumatic.*
(*b*) *Post-febrile* (or inflammatory).
(*c*) *Sclerotic.*

(*a*) *Traumatic* cases comprise those in which mental defect has resulted from injury or violence of such a character as to interfere with the normal cerebral development. The earliest to be named is the interesting class of birth palsies (cerebral diplegia) due to intra-cranial injury at the time of birth. Whilst instrumental delivery has been blamed by certain writers (Winkler, Bollaan, and others) for this result, it is probable that protracted pressure in an unassisted, unduly-prolonged labour is a much more potent factor in the causation of meningeal hæmorrhage and mental defect; in fact, in the etiological statistics gathered by Dr. Beach and the present writer, protracted labour figures more than four times as often as forceps delivery as a probable cause of mental defect. Meningeal hæmorrhages thus caused specially affect the Rolandic area, but the resulting scleroses may extend and involve not only the muscular, but the mental powers. Common characteristics of these cases are rigidity and spastic contractures of the limbs, obvious even at an early age, but becoming more embarrassing as time goes on. The power of speech as well as of walking is interfered with, and whatever mental intelligence exists is masked by these physical defects.

(*b*) Under the heading *post-febrile* or *inflammatory* we include cases resulting from various forms of meningeal or cerebral inflammation arising either in the course of acute infectious disease or otherwise produced. Not a few cases of mental deficiency are attributed to the consequence of attacks in early life of small-pox, typhoid fever, scarlatina, and whooping-cough, and when so caused the development of the convolutions seems to have been checked by thickened membranes and changes in the coats of blood-vessels interfering with nutrition; or it may be, as in severe cases of whooping-cough, from hæmorrhagic extravasations. Morbid hypertrophy of the brain, first described by Virchow in 1856, characterised by a large piled-up cranium, with increased circumference above the level of the superciliary ridges, is associated with inflammatory changes, but needs to be carefully distinguished from hydrocephalus.

(*c*) *Sclerotic* cases include a considerable number of cases of mental defect in which cerebral degeneration is either the terminal condition of inflammatory processes (thus connected with class *b*), or arises as a separate morbid process described by Bourneville, under two principal forms (1) *atrophic*, and (2) *tuberous*. The affection usually begins in early infancy, but is sometimes deferred to the second year. The frontal and occipital lobes are specially affected by the sclerosis. Repeated spasms occur, often localised to particular groups of muscles, and some loss of power follows, amounting occasionally to hemiplegia. The child is dull, inattentive, and helpless; the mental torpor is usually progressive, though it may be interrupted by brighter intervals.

ANATOMO-PATHOLOGY

I. CONGENITAL CASES.—(*a*) *Microcephalus.*—The cranial peculiarities of this type have been already described. Here we may state that premature synostosis of the sutures of the skull is in our experience rare in this variety, so that the operative measures founded on this hypothesis are illogical. The common characteristic of the microcephalic brain is posterior shortening of the cerebral hemispheres, the cerebellum being thus left uncovered to a greater or less extent. All parts of the brain are on a small scale, but it is the occipital lobe which is least developed, pointing to formative processes being arrested probably between the third and fourth months of gestation. The anterior lobes are imperfectly developed, but yet more advanced than the posterior. Histologically the brain cells are simple in formation, rounded or oval, with but few and stunted processes.

(*b*) *Porencephalus.*—In this condition fluid takes the place of brain substance, a cavity being found usually on the surface of the cerebral hemisphere extending to the lateral ventricles. The cavity may communicate with the arachnoid sac, or be separated from it by the visceral arachnoid. The defect is usually congenital, but may be due to atrophy after circumscribed inflammation.

(*c*) *Hydrocephalus* may be divided for pathological purposes into two main classes:—

1. *Primary*, including idiopathic cases.
2. *Secondary*, those secondary to meningo-encephalitis, or to tumours.

In the first class of cases there are two varieties, congenital and acquired, and according to Meynert, they may be distinguished by the fact that in the former the lateral ventricles are extended in their long diameter, in the latter transversely. In both varieties there is an excessive accumulation of fluid, and in a case of profound idiocy recorded by Fletcher Beach, as much as 37 ounces was found. Considerable amount of fluid may co-exist with only moderately impaired intelligence, as in a case reported by Shuttleworth of a girl of eleven only slightly imbecile, who conversed rationally till within an hour of her death, when it was found that her large globular skull contained 20 ounces of fluid to 36 of cerebral matter. A chronic intra-ventricular meningitis (congested ependyma) is presumed to be the source of the effusion; but besides hypersecretion there may be blocking of foramina and lack of normal absorption in the exterior serous cavity. In extreme cases the septum between the ventricles may disappear, and the cerebral envelope become thinned in a marked degree. In secondary hydrocephalus there is obliteration of the foramina of Monro, Majendie, or Miezerjewski, or obstruction of the veins of Galen, by the pressure of tumours or meningitis.

(*d*) The characteristic pathological features of *mongoloid idiocy*, in addition to the physical features already alluded to, are a brain short in antero-posterior measurement, the occipital lobe being often imperfectly developed, coarsely convoluted, and with few secondary convolutions. Wilmarth remarks of five mongoloid brains examined by him that they were all of fair size for imbecile brains, the pons and medulla alone being very small, indeed only about half the usual relative weight. Archibald Garrod and John Thomson have noticed the frequency with which cardiac imperfections are found in young mongoloid idiots; and the latter has recorded a three-year-old case in which he found incompetence of the tricuspid valve, probably due to intra-uterine endocarditis. These children have as a rule poor stamina, and are apt to succumb to tubercular disease early in life.

(*e*) *Sporadic cretinism* has a literature of its own, and for its pathology we refer the reader to the article, "Cretinism," vol. ii.

(*f*) *Primarily Neurotic Cases.*—The pathological features of this class vary considerably, but Clouston lays much stress upon the prevalence of the pointed Gothic-arched *neurotic* palate, as associated with neurotic diathesis in contradistinction to the deformed palates which obtain in the other forms of idiocy and imbecility. Eugene Talbot of Chicago has remarked the comparative preponderance of V-shaped palates amongst upper-class defective children—usually of the neurotic type—in an examination of these and of children in public idiot asylums. It is in this class that a typical asymmetry of cerebral hemispheres, both as regards bulk and as regards gyral development, have been noted by Spitzka, Mills, and others, and in one case, which fell under the notice of the present writer, small and slender convolutions (*microgyric*), more or less curling, were found to exist markedly in the frontal region of the left hemisphere. But it is probably in the nerve cells themselves, rather than in the arrangement of convolutions, that the essential abnormalities reside; and structural peculiarities akin to those described by Bevan Lewis in the epileptic brain, such as inflated spheroidal cells, with deficiency of protoplasmic processes, may be looked for in these cases of nervous instability.

II. Developmental Group.—(*a*) *Amaurotic Cases.*—In these the essential change is one of degeneration of the pyramidal cells of the cortex, most marked in the convolutions other than the superior frontal and middle temporo-sphenoidal. There is considerable optic atrophy, and the retina at the yellow spot is slightly detached from the choroid.

(*b*) In *eclampsic* cases the pathological lesions usually met with are, localised hæmorrhagic products and thickened adherent membranes interfering with normal nutrition of the convolutions.

(*c*) In *epileptic* cases the cerebral changes consist, according to Bevan Lewis, of hardening of the neuroglia fibre cells, diffuse or focal, with gradually advancing destruction of the nerve cells. "Cells from the brains of epileptic imbeciles of adult age (twenty and over) often show in considerable areas a development of neurons or nerve cells not greater than that of a healthy child between the ages of three and five." Vacuolation of the cortical cell-nuclei had also been observed by this authority and by Andriezen. Echeverria sums up the morbid conditions as consisting of diminution of the cortical substance and of the nervous elements, with exuberant genesis of connective tissue undergoing retrograde metamorphosis.

(*d*) *Syphilitic cases* terminating in juvenile dementia and paresis—the *juvenile general paralysis* of Clouston and other writers—present characteristic atrophic changes in the convolutions, most marked in the frontal and central portions of the brain. In a case reported by the present writer in the *American Journal of Insanity* for 1888, the brain weighed only 44 oz., the frontal convolutions were exceedingly small, and there were signs of endoarteritis. Recently Mott has studied the pathology of 30 cases of juvenile general paralysis, and in 80 per cent there were undoubted signs or history of congenital syphilis, and in the remaining 20 per cent it could not be excluded. Degenerative changes in the nerve cell due to inherent defects in the germinal plasm of the parents are assigned by him as the origin of the mental symptoms.

III. Passing to ACCIDENTAL or acquired cases we first consider the pathology of—

(*a*) *Traumatic cases*, the most interesting group of which is that of birth-palsies. The most common cause is (according to Freud, M'Nutt, and others) meningeal hæmorrhage spreading to the great longitudinal fissure, and pressing upon the upper edges of both hemispheres, leading to atrophic cortical changes. Depending on their extent, spastic rigidity, paraplegia, or cerebral diplegia are produced. In cases resulting from falls on the head, concussion, compression, and meningeal hæmorrhage may be combined as primary causes with degenerative secondary changes. Collier, however, in a recent paper in *Brain*[1] has maintained that the initial degeneration of the pyramidal cells of the cortex is the essential lesion in infantile cerebral palsies, contending that the importance of birth, injuries, and meningeal hæmorrhage, as causal factors in the production of diplegia, has been overestimated. He judiciously remarks that "every degree of mental impairment is met with in these cases from slight mental dulness to complete amentia," the degree of mental defect not always corresponding to the severity and rigidity of the paralysis, and depending upon the greater or less affection of the præfrontal lobes.

(*b*) *Post-febrile or Inflammatory Cases.*—In these cases are found thickened membranes and inflammatory products pressing upon the convolutions, and so checking their development, or interfering with the nutrition of the nerve cells. Sometimes also there is thickening of the cranium with premature ossification of the sutures. Culcrre and Bernadini have observed increase in neuroglia, fatty and pigmentary degeneration of nerve cells, and atrophy of their processes, with diminution in number of ganglion and pyramidal cells.

In *hypertrophic cases* of idiocy Rokitansky and others have held the view that increase of neuroglia, with fatty and pigmentary degeneration of the nerve cells and atrophy of their processes, are the characteristic lesions —at any rate of the later stages of the disease. The brain is heavy. Dr. Beach has recorded a case in which it weighed 62 oz.

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[1] *Brain*, vol. xxii. p. 373, etc.

Amongst the *microscopical* changes found in the brains of idiots many have incidentally been mentioned under the different types. We may, however, sum up the abnormalities by saying that the brain cells are usually rounded or pear-shaped and deficient in processes. Often the nucleus has retracted protoplasm about it with granular matter externally. Hammarberg, whose histological researches upon the brains of mentally defective children are the most complete series we possess, demonstrates that there is a definite relation beween the number of the pyramidal and spindle cells and the degree of intelligence. With low-grade idiots these cells are few and far between, and they increase gradually as intelligence increases, being however still abnormally scarce as compared with the normal, even in cases of slighter mental deficiency, known (in this country) as "feeble-mindedness."

Diagnosis and Prognosis.—The diagnostic signs of the several types of idiocy have been set forth to a considerable extent in the classification. But the practical question as to the existence of mental deficiency in a given case, especially when marked typical features are not present, is one which needs more detailed consideration. Comparatively seldom will a mother admit mental defect in her offspring until absolutely driven to do so: the child is said to suffer from some sensorial defect, and is often taken the round of eye, ear, and throat specialists before being submitted to the judgment of the expert in pædo-psychiatry. It is desirable on many grounds that an early diagnosis of infantile mental infirmity should be made, and the following hints may be of use to the general practitioner:—

Cranial abnormalities, which in marked cases may be early observed, *e.g.* in microcephalic and hydrocephalic cases, are distinctly diagnostic. Taking a child at the age of nine months, it may be said that a circumferential head measurement much under 17 inches, or much over 19 inches, is indicative of probable abnormality. The brachycephalic head of the Mongol type, the expanded flattened-out cranial vault, with depressed and open fontanelles, of the cretin, and the asymmetrical skull of the paralytic type, are all suggestive. The rickety form of head, with frontal and occipital bosses, is frequently seen (in large towns at any rate) associated with the less-marked forms of mental defect. "The persistence of the medio-frontal suture, or the existence of a medio-frontal ridge towards which a narrow forehead tapers, may be accepted as signs of imperfect development of the frontal lobes," a condition often seen in defectives of the "primary neurotic" type.

Certain *abnormalities of physical formation and development*—("stigmata of degeneration," as some have called them)—such as hare-lip, fissured, contracted, or deformed palates, facial asymmetry, macroglossus, abnormally implanted ears with absence of lobule, epicanthic folds extending across the curuncle, coloboma iridis, defects of ocular media, nose depressed or indented at bridge, polydactilism, cardiac imperfections with cyanosis,—all these will be suggestive to the practitioner of abnormality (which may be mental as well as physical), especially when several of these *stigmata* coexist. Much importance has been attributed by some to a high and narrow palate as a sign of congenital mental defect, but this alone is not conclusive, as it is found in many talented, though neurotic persons.

But after all it is by *abnormality of nervous action,* in conjunction with the consideration of the physical defects just named, that the diagnosis of mental abnormality is best made. The baby who lies listless and apathetic at a year old, and does not attempt to use its legs, or to make the usual infantile sounds, is doubtless mentally deficient; but there may be, on the other hand, excessive nervous irritability and irregular movement, perhaps spasmodic twitchings of certain groups of muscles, or a general tremor. In the paralytic type of cases nystagmus is often present. Broadly speaking, the non-paralytic child who does not attempt to talk or to walk at the usual period may be suspected of some degree of mental deficiency.

Then again *defects in nutrition*, especially if these defects persist in spite of appropriate feeding, are often symptomatic of constitutional defect associated with atrophic brain conditions, which impede the due evolution of intelligence. Warner has recorded an excessive ratio of mal-nutrition observed in the children of poor-law schools as compared with children in ordinary elementary schools, in spite of the good dietaries of the former, and this is coincident with about double the proportion of feeble-minded in the former as compared with the latter.

As has been well remarked by John Thomson,[1] "Many of the mentally defective infants we meet with present none of the grosser physical defects (above named); in these we may have to found our diagnosis entirely on the degree of delay in the development of the bodily and mental powers present, taken along with surrounding circumstances. Thus we must think of mental deficiency if a child is very long of learning to hold up his head, to sit, to use his hands, to stand, and to walk, and especially if he does not show the natural desire of the healthy infant to exercise all his developing motor faculties. Or, again, if he is backward in noticing objects, and in responding to the smile and voice of his mother and nurse, and, at a later stage, backward in speaking." Due allowance must, of course, be made for merely temporary backwardness resulting from infantile illnesses attended by debility.

As regards prognosis the typical groups are significant. Thus in microcephalic cases the degree of improvement possible varies very much with the size of the head. Little can be expected when the circumference is less than 17 inches; but when it is 18 or 19 inches the powers of observation may be trained, and manual occupations may be acquired of practical use in after life. With hydrocephalic cases some educational progress may be looked for when all acute symptoms have subsided; and the present writer is acquainted with cases of this type in which very satisfactory results have been obtained by training. In porencephalic cases improvement is very much dependent on the extent of the lesion; but in some cases much amelioration has followed training of the uninjured hemisphere of the brain. In mongoloid cases there are various grades, but there is some degree of imitative power in all, and this may be utilised in the higher class for teaching simple mechanical pursuits. The tendency to tubercular disease developing about the period of puberty is, however, a drawback to be kept in mind. Cretinoid cases treated with thyroid develop wonderfully both physically and mentally, and from being little more than inert masses, become at length suitable cases for ordinary school instruction. Primarily neurotic cases require great care in bringing up and educating, and they are liable to develop chorea and other nervous affections, and later may fall the victims of adolescent insanity. The prognosis of all the developmental types is unfavourable, though exceptions may perhaps be made in the cases of eclampsic and epileptic children ceasing to suffer from fits. Amaurotic cases always die about the end of the second year; and syphilitic cases as a rule degenerate after puberty, and, after two or three years of increasing dementia and paralysis, perish miserably. Traumatic cases attended with some degree of paralysis often improve mentally much more than would be expected from their ungainly physical features, especially in the slighter cases of birth palsy, attaining under proper drill and manual training even some amount of dexterity. As a rule inflammatory cases are unsatisfactory, the development of brain being limited by toughened membranes and inflammatory products; and the prognosis of sclerotic cases is invariably bad.

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[1] "On the Diagnosis of certain Forms of Imbecility in Infancy," *Scottish Medical and Surgical Journal*, March 1898, p. 204.

Treatment and Training.—A few words on the subject must suffice here: those interested in the subject, which is necessarily a specialty, being (as Bourneville calls it) *medico-pedagogic,* are referred to the works of Séguin, Ireland, and Shuttleworth. Briefly described, the system may be stated to be a combination of hygienic and appropriate medical treatment with specially adapted physical, manual, and educational exercises. The training of a mentally deficient child cannot be commenced too soon; and the misfortune is that the mother, the natural guardian of the child, is by reason of a common neuropathic heritage, often the very worst person to commence it. Séguin has well laid down the principles on which to proceed in the following paragraph:—"As soon as any function is set down as deficient at its due time of development, the cause must be sought and combated; if external, removed; if seated in the nervous apparatus, counteracted by the earliest course of training and hygienic measures. The arm of the mother becomes a swing or a supporter; her hand, a monitor or a compressor; her eye, a stimulator or a director of the distracted look; the cradle is converted into a class-room or gymnasium." To descend to detail, the first matter requiring the maternal attention is the cultivation of cleanly habits, and much may be done by methodical attention; the second is the training to definite effort of the motor apparatus, *e.g.* by getting the child to hold on with his hands and to exercise his legs; the third is to cultivate the rudimentary powers of speech. By slow degrees the child may be taught to undress and to dress, to feed himself, and to wash and be personally neat. This much attained, comes the rôle of the trained teacher acting under medical direction, who will note and cultivate the child's capacities, and know how to exercise its incapacities; and if the "3 R's" are unattainable (as in many cases they will be) apply such manual training as will not only help the brain development, but will also fit the pupil as far as possible for some employment—it may be but a humble one—in the practical business of life.

For the most pronounced cases of mental defect, those generally recognised as idiots and imbeciles, there is no doubt that training in an institution, where a staff of skilled nurses as well as of teachers is available, is the best course, inasmuch as attempts at education of single cases at home are usually unpracticable, or if practicable, ineffective. Under proper conditions of classification, indeed, the aggregation of such children into small groups for teaching purposes is of distinct advantage, as the "sympathy of numbers" helps both teachers and taught. The resources of an institution also furnish facilities, not to be obtained elsewhere, for the necessary manual and industrial training. The more nearly the domestic arrangements can approximate to those of family life the better for the children, and small groups in cottage homes are to be preferred to larger aggregations in the wards of an asylum. Employment in the open air, in simple garden or farm work, is of great value, so that training institutions should always be in the country and on sites that are high and dry. With regard to children whose mental deficiency is less marked—those known as merely "feeble-minded"—special instruction in small day classes has of late years been organised for such by several of the school boards, and under the Elementary Education (Defective and Epileptic Children) Act of 1899 a special grant in aid is now allowed by the (English) Board of Education. To secure this grant the law requires that each child should be certified in a prescribed form by a recognised medical officer, to the effect that "not being imbecile, and not being merely dull and backward, he is by reason of mental (or physical) defect incapable of receiving proper benefit from instruction in an ordinary public elementary school, but is not incapable, by reason of such defect, of receiving benefit from instruction in a certified special class or school."

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Mercury. *See* TOXICOLOGY.

Mesenteric Glands (*see also* PERITONEUM).

Mesenteric Glands.—These glands lie between the layers of the mesentery and round the trunk of the superior mesenteric artery; they receive lacteals from the small intestines and colon as far as the sigmoid flexure, and their efferent vessels join those of the cœliac glands to form an intestinal lymphatic trunk opening into the thoracic duct. The cœliac glands surround the cœliac axis and the aorta above the superior mesenteric artery, and are concerned with the functions of the stomach, upper part of the duodenum, etc. (*see* "Lymphatic System, Pathology of," vol. vii.).

It cannot be too strongly emphasised that a diseased state of these glands represents a vital reaction of the gland to a specific instant rather than a disease of the gland in the ordinary sense of that term. Hence the importance of a knowledge of the structure and functions of lymph glands already given in a previous volume, where the author has clearly indicated the manner in which that function is altered by the access of various pathogenic agents. Of these by far the most important is the tubercle bacillus. Tuberculosis of the mesenteric glands, or, as it is sometimes designated, tabes mesenterea, is of frequent occurrence especially in children. When present in older subjects it is usually accompanied by involvement of the peritoneum, but in children it is quite common to find pronounced disease in the glands with little or no affection of the peritoneum, and no apparent lesion in the intestinal mucous membrane. There is no doubt that the tubercle bacilli frequently find their way to the mesenteric glands *via* the alimentary canal without leaving any trace of their track. A present desideratum, however, is a record of the exact histological appearances of the mucous and submucous coats in these cases; it is more than likely that distinct evidence of local reaction (increase of lymphoid tissue, etc.) would be demonstrated at the parts which had given access to the bacilli.

Clinical Features.—Subjective symptoms may be very slight or indeed absent in the earlier stages of the disease, but as a rule some evidence of ill-health has been noted for a varying period. An unnatural peevishness, a capricious digestion, and a diminution in the mental and physical vigour of the child are the symptoms usually observed by the parent. As the condition advances it may be noticed that the abdomen is slightly enlarged, and the child manifests indications of discomfort or pain when the abdomen is handled. Accompanying this, there are indications of abnormal intestinal action, notably constipation or diarrhœa; an examination of the stools showing evidence of deficient digestion and abnormal fermentation in the intestinal contents. If the condition be progressive, all the subjective symptoms become intensified, and the condition of the stools becomes particularly pronounced.

The objective symptoms are very slight in the earlier stages of the disease. The child may appear out of sorts, and nothing more may be indicated. At this stage it is especially important that a frequent examination of the stools be made. An excess of mucus, the presence of undigested food, and marked fœtor from abnormal decomposition will indicate the existence of a marked local weakness which is full of significance to the trained observer. When the disease becomes more pronounced the physical signs in the abdomen are unmistakable. Their severity will depend (*a*) on the presence or absence of pressure of the glandular masses on the portal vessels, and (*b*) on the coexistence of involvement of the peritoneum. If definite obstruction exists, ascites with marked distension of the superficial abdominal veins will be a feature. In some cases the fluid is more or less encysted, due to the presence of adhesions which complicate the diagnosis. In the early stages a physical examination of the abdomen may reveal nothing but a slight undue prominence of the abdomen, which feels abnormally resistant on superficial and deep palpation. At this stage examination under an anæsthetic is of the utmost service; this sometimes reveals a few deep-seated enlarged glands. It is also advisable at this stage to make a rectal examination on an empty bowel, as this may be of service in demonstrating the existence of glands not otherwise readily detected. As the conditions become more marked, the rigid doughy feeling of the abdomen, which is the most striking characteristic of the disease, develops, and is accompanied by the engorgement of the superficial veins already referred to. If the disease is not limited to the glands but has involved the peritoneum, thickened bands may be clearly palpable in addition to the glandular masses. The state of the stools should be carefully investigated at every stage of the disease; continued abnormal decomposition with evidences of catarrh are prominent features.

The diagnosis is as a rule easy. The two points of greatest importance, *e.g.* examination under an anæsthetic and a rectal examination, have been already emphasised. The disease is in many cases remarkably amenable to treatment.

The prognosis is good if the condition be early recognised and submitted to appropriate treatment. If the patient only come under observation in the later stages of the disease, when the child's general strength is reduced and the local disease has considerably advanced, the outlook is highly unfavourable. In addition to the danger attendant on the toxines of the tubercle bacilli, there is always the possibility of the supervention of intestinal obstruction which will call for active surgical interference. This danger is naturally more pronounced in cases associated with marked thickening and adhesions of the peritoneum. The prognosis will also vary with the presence or absence of pulmonary complications.

The line of treatment is (*a*) to give a diet suited to the physiological capacity of the child, aided, if need be, in bad cases by judicious use of stimulants—the index here is the state of the appetite, and the state of the dejecta; and (*b*) endeavour to raise the resisting power of the tissues generally, by general hygienic and tonic treatment; and (*c*) various local measures, *e.g.* the use of mercurial and other ointments.

Further details as to treatment will be found in the article on "Lungs, Tuberculosis of" (vol. vii.), and "Bronchial Glands" (vol. ii.).

Metatarsalgia. *See* DEFORMITIES.

Meteorology.

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THE meteorological conditions of any locality are comprised under the two heads of the climate and the weather, the former representing the permanent and unvarying, the latter the temporary and changing meteorological phenomena. The climate exhibits an annual cycle with more or less regular curves, on which the weather superposes minor waves, which, modifying the climate, derive their special characters from it; like causes producing diverse consequences according as the antecedent conditions under which they act, and by which their action is controlled, differ in the several instances.

Climate is the general resultant of (1) temperature, altitude, and the distribution of land and water, and (2) humidity, rainfall, prevailing winds, evaporation, radiation, etc., modified by soil, aspect, and various local conditions.

Weather, on the other hand, indicates transient deviations in one direction or another from the normal climatic conditions observed at any given time of year, and is primarily dependent on the differences of temperature and consequent movements of the air caused by the sun's rays successively impinging at various angles on the earth's surface, and the further disturbances resulting from the different amounts of absorption and radiation of heat, and of evaporation from land and water as each is exposed to the direct rays of the sun or not.

The ever-changing phenomena of weather cannot, therefore, be profitably studied apart from, or save in the light of the four great conditions which are the determinant factors of the local climate, viz. temperature, altitude, rainfall, and humidity.

Temperature is primarily dependent on latitude, that is, on the mean and seasonal altitude of the sun and the angle at which its rays impinge on the surface of the earth, but is locally and periodically modified by the direction and character of the ocean currents and of the prevailing winds, whether warm or cold. Thus Labrador and Newfoundland are in the same latitudes as the British Isles and France, but while the western shores of the latter are washed by the warm Gulf Stream from the West Indies, the former are chilled by the icy currents flowing southwards from the eastern coasts of Greenland and Baffin's Bay. These general characters, dependent on the presence or absence of the influence of the Gulf Stream, may be observed in the difference between the dry, bracing climate of the East Coast, from Norfolk to Aberdeen, and the mild humid climate and heavy rainfall of Ireland, Devon, and Cornwall. The unimportant part played by latitude alone is shown by the fact, that in the Shetlands snow rarely lies for many days together, though the humidity of the atmosphere and the want of clear sunshine preclude the maturation of cereals, oats excepted. But mean temperatures, unless given for every month in the year, and with the maxima and minima of the monthly variations, afford no useful information as to the true character of a climate. The annual means of London and Newchwang on the Gulf of Pechili are the same, about 50° F., but the means for January and July are for the former 40° and 60° F., and for the latter 0° and 80° F.; and while the mean annual isothermal lines of England pass through Germany, those for July and January diverge to Finland and Greece respectively.

These types of climate are often distinguished as insular and continental, the narrow range of the annual curves in the one being due to the proximity of the ocean; since water, if it absorb heat more slowly than the land, parts with it slower still, and the greater amount of vapour in the air in summer detracts from its diathermancy and moderates the heat of the sun's rays; while the tendency to extremes characteristic of continental climates is intensified in every way when the general elevation of the country is considerable, as it is in southern Germany.

THE BAROMETER

Ordinary hall barometers are not available for accurate scientific observations, for the levels of the mercury in the tube and the cistern vary inversely as their respective sectional areas, or the squares of their diameters, while the scale is necessarily fixed at 760 mm. or 30 inch. of the mercury. Thus if the diameters be $\frac{1}{10}$ in. and 1 in. *i.e.* as 1 : 10, the squares of these being 1 and 100, a rise of 1 inch in the tube involves a fall of $\frac{1}{100}$ inch in the cistern, which must be added to the reading on the scale, and *vice versâ*, constituting the correction for capacity.

In the standard or Fortin's barometer this defect is obviated by making the bottom of the cistern movable, that the varying level of the mercury in the cistern can always be so adjusted as to coincide with the zero of the fixed scale indicated by an ivory peg pointing downwards. The scale should be engraved on the tube or on a brass rod, the coefficients of expansion of which are known, and not on or attached to the frame. The barometer should be hung perfectly perpendicularly, as indicated by a spirit or mercurial level attached to it, in a position sheltered from sun and rain, but in a good light.

To read the Barometer.—First note the temperature on the attached thermometer before it can be affected by the warmth of the observer's body. Then adjust the cistern by working the screw beneath it up or down until the point of the ivory peg just meets its image reflected on the surface of the mercury. Gently tap the barometer twice or thrice to overcome any adhesion of the mercury to the glass, and standing with the eye on a level with the upper end of the column, adjust the vernier so that its *lower* margin just shuts off the light above the curved surface of the mercury. If (Fig. 1, A) this correspond exactly with a line on the scale, the observation is complete; if not, note the line next below on the scale, and then following the marks on the *vernier* upwards note the first that coincides with one on the scale. Each figure on the vernier represents $\frac{1}{100}=0{\cdot}01$ inch, and each division $\frac{2}{1000}=\frac{1}{500}=0{\cdot}002$ of an inch, which together indicate the exact value of the excess of height of the mercury over the next lower mark on the scale.

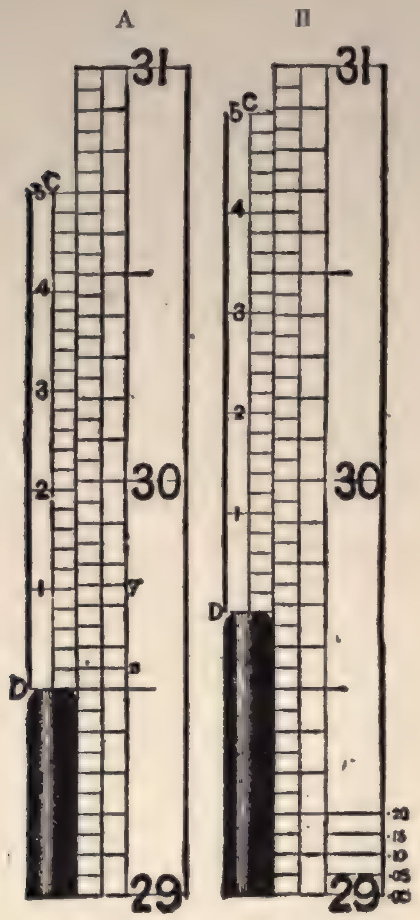

Fig. 1.

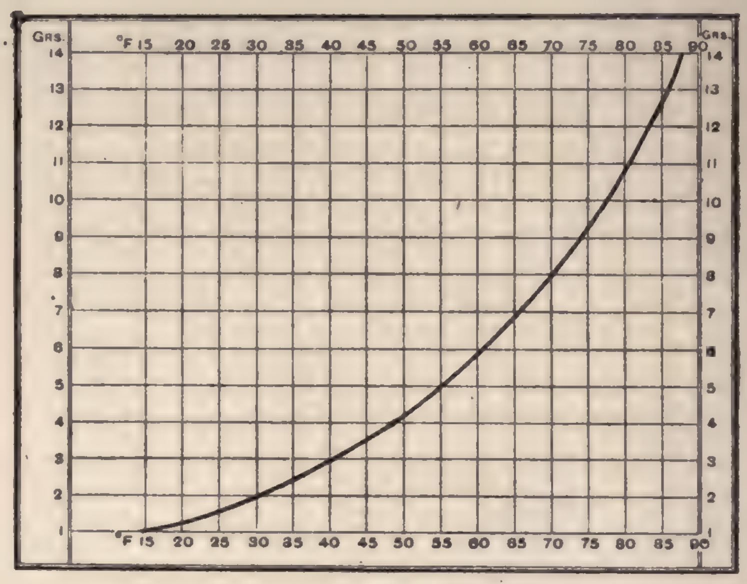

Fig. 2.

Thus suppose the mercury to stand a fraction above 29·650 inches on the scale, and the vernier having been adjusted, the first line to coincide with one on the scale to be the third above the figure 3, then, 0·036 is to be added to the 29·650, giving 29·686 as the correct reading (Fig. 1, B).

Sometimes two consecutive lines on the vernier may *appear* to coincide with two on the scale, the intermediate *odd* thousandth is then to be taken as the correct reading; thus in this case had the third and fourth lines *seemed* to coincide with lines on the scale the reading would have been the mean of 29·686 and 29·688, *i.e.* 29·687.[1]

There is another form, the siphon barometer, which requires no correction for capacity or capillarity. It is a simple J-shaped tube; the longer leg closed above, and containing the Torricellian vacuum, represents the tube of the ordinary form, while the shorter and open leg corresponds to the cistern, but the calibre being uniform throughout, the movement of the mercury, though in opposite directions, is equal in each leg, and the mercury in the longer having to support the atmosphere + the complementary or surplus mercury in the other, the height of the column is but half what it is in the cistern barometer. The zero is a point midway between the extremities, and a scale and vernier are attached to each leg, those on the longer graduated upwards, and those on the shorter or open one downwards. The atmospheric pressure is obtained by adding the two readings. With the recent improvements of a capillary connection between the legs, a lateral orifice instead of the open mouth of the shorter, and a Brunton's pipette to prevent the possibility of the vacuum being broken, it cannot get out of order, and is well adapted for the determination of altitudes in mountain ascents or for use on board ship.

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[1] The vernier being divided into 25 parts, together equal to 24 on the scale (viz. 0·05 or twenty-fourths of an inch), each of the former is less than one of the latter by $\frac{1}{25}$, *i.e.* by $\frac{1}{25}\times\frac{1}{24}=\frac{1}{500}=0{\cdot}002$ of an inch.

Corrections.—The index error, if any, and the correction for capillarity, are marked for every half-inch on Kew certificates. Correction for temperature, by which all readings are reduced to what they would be at zero (0° C. or 32° F.), is calculated from the coefficients of expansion of mercury and of brass, the material of the scale, by Schuhmacher's formula. This correction eliminates the disturbing influence of temperature on the materials of the instrument, but does not affect that on the atmosphere, in the pressure exerted by which it and humidity are the efficient factors.

The results, as applied to barometers with brass scales extending from the cistern to the summit of the tube, are given in the following table for 27 and 30 inches, and for every 10° F. above freezing-point. Those for intermediate heights and temperatures may be found by proportional parts with approximate accuracy.

Temp.	27 in.	30 in.	Temp.	27 in.	30 in.	Temp.	27 in.	30 in.
0	+ ·069	+ ·077	40	– ·028	– ·031	80	– ·124	– ·138
28	+ ·001	+ ·001	50	– ·052	– ·058	90	– ·148	– ·164
29	– ·001	– ·001	60	– ·076	– ·085	100	– ·172	– ·191
30	– ·004	– ·004	70	– ·100	– ·111			

Correction for Altitude.—The mercury falls approximately $\frac{1}{1000}$ inch = 0·001 inch for each foot above the sea-level, subject to a slight variation dependent on temperature and humidity. The following table gives the *addition* in inches at 30 and 27 inches of pressure and 0°, 40°, and 80° F. for 10, 100, and 1000 feet of altitude. Intermediate heights are calculated proportionately. The Ordnance standard is the sea-level at mid-tide at Liverpool.

Height in Feet.	Temperature of External Air.		
	0° F.	40° F.	80° F.
When the Barometer at sea-level reads 30 inches.			
10	·012	·011	·010
100	·123	·112	·103
1000	1·208	1·105	1·017
When the Barometer at sea-level reads 27 inches.			
10	·011	·010	·009
100	·111	·101	·093
1000	1·087	·994	·915

Aneroid barometers are extremely sensitive, and need no corrections for expansion, etc., but being very liable to get out of order from the delicacy of their construction, they require to be frequently compared with a standard barometer, and all observations of a permanent character should be thus verified. They are from their portability and sensitiveness, especially convenient for measuring heights in surveying and in ascending mountains, for which the differences between the readings in hundredths of an inch × 9 may be taken as the elevation in feet, since at ordinary temperatures 0·1 inch corresponds approximately to differences of 90 feet.

A remarkable effect of variations of atmospheric pressure, of considerable interest from a medical point of view, is their influence on the movements of the ground air; or that contained between the particles of pervious soils, which not being immediately affected by changes in the temperature and humidity of the external atmosphere, remain for a time at a higher or lower density. The effect of a sudden fall of the barometer, *i.e.* of a rarefaction of the atmosphere, is an escape of the hitherto compressed ground air; and that of a rapid rise, on the other hand, is a descent of the atmospheric air into the earth, until the underground pressure or density and that above are equalised. This is the explanation of the phenomenon of the "blowing wells" at Northallerton, from which a strong outward current of air issues during and for some time after a fall of the barometer, and into which a like current rushes during and after a rise.

TEMPERATURE

The sources of terrestrial heat are two: (1) that still retained in the body of the globe itself; and (2) that received from the sun. The latter being in the form of radiant heat does not raise the temperature of space nor that of the atmosphere, especially in its higher and rarer strata to any sensible degree, until by impinging on the surface of the earth the rays are converted into dark heat, which is absorbed, radiated, or conducted by matter in proportion to its conductivity, and, as regards air, its density. Vapour, even in the perfectly gaseous form, detracts from the diathermancy of the air, as does smoke, though its presence be scarcely perceptible to the eye. It is thus that some fruits fail to mature in cities, though they ripen well in the country, even where the temperature is lower.

The effects of the unimpeded solar rays, warming the bodies on which they fall without sensibly raising the temperature of the intervening air, is well seen at the health resorts of the Engadine, where invalids bask in the sunshine, reclining on couches, sheltered from the wind, and often dropping their furs or cloaks when the shade thermometer indicates temperatures below zero. The attempts made to secure, without the cold, the fullest benefits justly ascribed to the action of the solar rays on the unclothed body, in the so-called sun bath, though they fail to overcome the *vis inertiæ* of habit, are in the highest degree reasonable; and it is much to be wished that custom and fashion should sanction a style of dress, for which Greek and Roman art would furnish abundance of models, that while fulfilling the reasonable demands of simple decency, should permit the free access not only of air, but, during such time as the sun's rays have much power, of light to the surface of the body. The rosy or ruddy complexion of the healthy resident or sojourner in the country, the result of an active cutaneous circulation, and unlike the browning that often accompanies it, owing nothing to the deposit of pigment, is admired and envied by the pallid denizen of the city; but if it be an indication of health and vigour, why should not the limbs and chest share it with the face and hands?

The pallor bred in ill-lighted dwellings is not a merely superficial condition; not only are such houses haunted with microbes, and are hot-beds of infectious and infective diseases, but there is no doubt that the want of air and light conduces to and intensifies disorders of nutrition, as rickets, which is especially an urban disease, and in Australia and South Africa is well-nigh unknown.

THERMOMETRY

The thermometers required for the observation of temperature under its different aspects are (1) the shade maximum, (2) shade minimum, (3) solar radiation, and (4) terrestrial radiation. They should all be self-registering, and it is well to have the bulbs carried beyond the frames, not, as in the ordinary instruments, enclosed in metal grids for protection.

Shade thermometers are best mounted in a hut of stout boards with a ridge roof, and louvred sides open below for three or four feet from the ground, so as to permit of the free movement of air and to avoid the accumulation of heat.

The box should be at least four or six feet square, with a door on the side least exposed to the sun. It should be put up where it will be open to the free movement of the air, but sheltered from the direct rays of the sun and from radiation from a wall. A good position is ten or twenty feet from the north side of a house.

The solar radiation thermometer is designed to absorb and accumulate the radiant heat of the sun with the minimum of waste. Its bulb is blackened, and it is enclosed in a glass tube or cylinder exhausted of its air. It should be fixed to a post about four feet from the ground, where it will be fully exposed to the sun all day.

The phenomena of terrestrial radiation are still imperfectly understood, but from time immemorial the cold produced by radiation and evaporation has been employed in the neighbourhood of Calcutta for making ice; an open plot of ground being excavated to a depth of two feet, and filled to about six inches from the surface with loosely laid dry rice straw, which, a powerful radiator, serves also to intercept the heat given off from the earth. On this are spread shallow porous earthen pans of water, which if the sky be clear, the air dry, the temperature not above 50° F., and the wind not strong enough to keep the air from remaining sufficiently long in contact with the bed to acquire the requisite low temperature, freezes in the course of the night. With the dry north and north-west winds as much as a ton of ice may be obtained from each 240 square feet, but none is formed with the moister south and east winds even though the temperature be much lower.

The terrestrial radiation or grass minimum thermometer should be mounted close to but not in contact with the ground, usually on a grass plot, though some prefer a black board on the earth. When snow lies it should be laid on it. Its purpose is to record the lowest temperature reached in the night close to the ground from loss of heat by radiation from the earth, which on clear nights is often much lower than that of the air above, and is the cause of the deposition of dew and hoar frost.

All thermometers should be graduated on the glass tube itself to tenths of a degree.

The shade thermometer should be read at least twice or thrice daily, at 9 A.M. and 3 P.M., or 3 A.M., 3 P.M., and 10 P.M. The maximum and minimum thermometers are usually read early in the morning when the maximum is assumed to have been reached during the afternoon of the previous day. But it would be better that they should be read twice daily, since in winter, when the sun's heat is feeble, the maximum may be reached in the morning and the minimum in the afternoon, instead of the night, being determined rather by the winds and clouds than by the hour of day.

In a few State-supported observatories continuous graphic representations of the fluctuations of temperature are taken by means of photographic or other self-recording apparatus, but it is very difficult, if not impossible, to integrate curves of such extreme complexity, and those obtained from 24 hourly observations are accurate enough for all practical purposes. From these it will be seen that in summer the highest mean daily temperature is found about 2 P.M., when the earth is still receiving heat faster than it is parting with it, and the coldest about an hour or two before sunrise, when the earth has been longest deprived of the solar rays; for the same reason that July and January, not June and December, are the hottest and coldest months.

But hourly observations cannot be made by private persons, and a fair estimate of the thermal character of a place or period may be drawn from the maximum and minimum as recorded irrespective of the hour by self-registering thermometers, and of the mean temperature by three daily observations at certain hours corrected by factors or coefficients. Sir J. Herschell gave the following formulæ for observations, t, t', and t'', taken at 7 A.M., 2 P.M., and 9 P.M., $\frac{t+t'+2t''}{4}$ or at 8, 3, and 10 $\frac{7t+7t'+10t''}{24}$.

Mr. Scott prefers the Greenwich hours of 6, 2, and 10, corrected by empirically determined coefficients for each month in the year, while Mr. Marriott has done the same for the maxima and minima.

HUMIDITY

Humidity is absolute or relative, the former term expressing the actual weight of aqueous vapour present in a given volume of air, and the latter the proportion that it bears to the possible maximum at the temperature for the time being, and is stated in degrees, that is, in percentages of the maximum or saturation. Thus 4 grains of vapour in the cubic foot represent saturation, or 100% at 50° F., but only 66% at 62° F., and 50% at 70° F. If the temperature sank rapidly to 42° F., at which 3 grains constitute saturation, 1 grain would be deposited as dew. The point at which the deposition begins, in this case 49° F., is called the dew-point. In other words, the dew-point is the temperature at which the amount of vapour actually present would suffice for saturation, so that given the temperature at the time and the dew-point, the actual weight of vapour present, as well as the relative humidity, can be calculated.

The following table gives the weight (in grains) of vapour in a cubic foot of *saturated* air at various temperatures from 14° to 88° F. From this it will be seen that at 80° F. the air is saturated by 11 grains, at 60° F. by 6 grains, and at 40° F. by 3 grains; and it is clear that if the humidity be 75 per cent at 60° F., dew will fall when the temperature sinks to 53° F., but if the humidity at 60° be only 50 per cent, dew cannot fall until a temperature of 41° is reached. With a day temperature of 60° and 75 per cent of humidity, the lightest frost will cause a heavy deposit of hoar frost, while with a temperature of 40° and humidity of 50 per cent none will fall unless the night temperature sink to 24°. Hence the greater damage to orchards in clear nights following warm days in spring than when the weather is dull and cold.

Weight (in Grains) of Water-vapour in a Cubic Foot of Saturated Air[1] *from 14° to 88° F.*

Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.	Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.	Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.	Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.	Temperature, ° F.	Grains of Water in cubic foot of Air to Saturation.
14	1·0	30	2·0	46	3·6	62	6·2	78	10·3
16	1·1	32	2·1	48	3·8	64	6·6	80	11·0
18	1·2	34	2·3	50	4·1	66	7·0	82	11·7
20	1·3	36	2·5	52	4·4	68	7·5	84	12·4
22	1·4	38	2·7	54	4·7	70	8·0	86	13·3
24	1·5	40	2·9	56	5·0	72	8·5	88	14·0
26	1·7	42	3·1	58	5·4	74	9·1		
28	1·8	44	3·3	60	5·8	76	9·7		

The sensations of damp and dryness depend on the degrees of saturation or relative humidity, and there may be far more aqueous vapour in the air on a hot "dry" day in summer than on a cold "damp" day in winter. Evaporation depends indirectly only on temperature, but directly on humidity, being most active when the air is *relatively* driest. It is not arrested even by freezing taking place from the surface of ice no less than of water, if the air be, as it often is during prolonged frosts, relatively dry, while in warm rainy weather it may be very small, and it ceases entirely when saturation is reached.

Humidity and evaporation are among the most important factors in the influence of climate and weather on health, and it is well to bear in mind that there is no necessary relation between the rainfall and the humidity of a place, the former being determined by geographical, orographic, and local physical conditions, the altitude and contour of the land, the proximity of the sea to mountain ranges, etc., while the humidity and evaporation depend largely on the nature of the soil, whether this be retentive of moisture or, on the other hand, either deep and pervious, or rocky and wholly impervious to water. The last, if elevated, may combine heavy rainfalls with a very low degree of humidity, and there are regions, as parts of Sind, practically rainless, where the air is never far removed from saturation, though such are not found in European countries.

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[1] When the air is thus saturated, the readings of the wet and dry bulb thermometers are the same; humidity less than 100 per cent is indicated by the lower reading of the wet bulb.

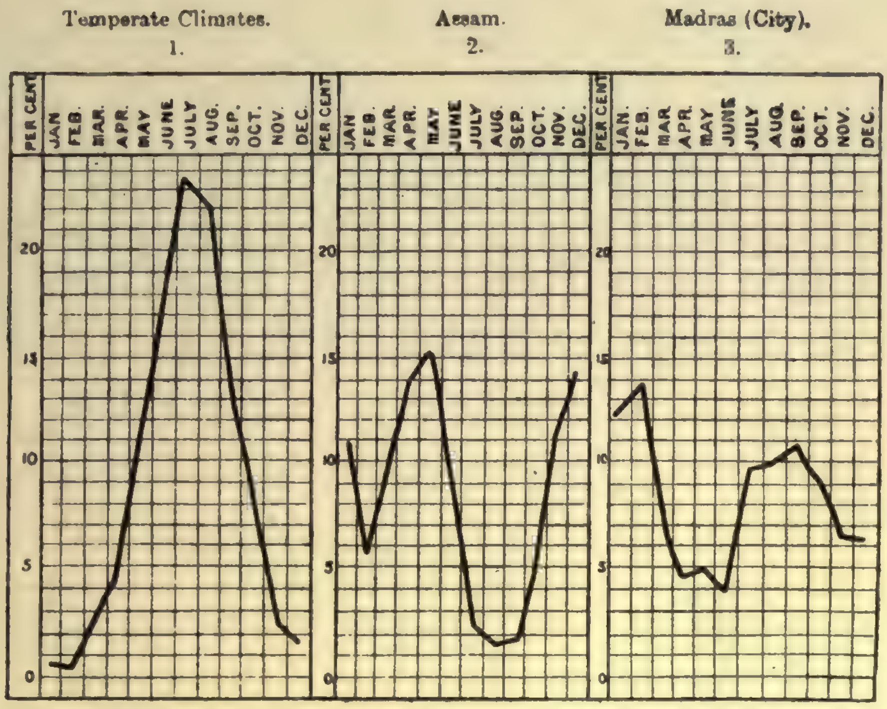
Temperate Climates. 1. Assam. 2. Madras (City). 3.

FIG. 3.

HYGROMETRY

The only hygrometer in common use is the combination of wet and dry bulb thermometers, the latter giving the actual temperature of the air, and the former that of evaporation, the dew-point being calculated from the difference between their respective readings by means of a series of empirical factors worked out by Mr. Glaisher. The instrument is placed in the shade, four feet above the ground, freely exposed to the wind, but protected from the radiant heat of walls, etc.

The wet bulb is covered with muslin kept moist by twisting round it a skein of cotton, previously boiled in a solution of carbonate of soda, and afterwards in ether, to remove all traces of fat, the other end of the cotton being immersed in a vessel of water. The cotton should be changed every fortnight, and the water should be rain or distilled. When the water freezes and the siphon action is arrested the muslin should be moistened with a sponge or brush, and allowed to freeze again before the observation is made; but should the temperature have meanwhile risen above the freezing-point, the muslin, etc. should be thawed with warm water, and the reading delayed until it has cooled down to the true temperature. When the air is saturated the readings of the two thermometers will be the same, and indicate the dew-point, otherwise that of the wet bulb will always be the lower, though above the dew-point so long as the air temperature is above freezing. When this is lower, and the wet bulb is, aş it should be, encased in ice, it will read 32° F. however low the dry one may have sunk.

USE OF GLAISHER'S TABLES

Multiply the difference between the readings of the two thermometers by the factor (Table B) opposite that of the dry bulb, and deduct the product from the latter; the remainder will give the dew-point. Then finding (Table A) the weight of vapour corresponding to the dew-point, and therefore actually present, and that which at the actual temperature would constitute saturation, the proportion that the former bears to the latter will be the degree of humidity for the time being. Thus, *e.g.* the dry bulb reading 67° F. and the wet 62° F. gives the difference of 5° F. The factor in Table B opposite 67° F. is 1·8, which × 5 = 9, and 67° − 9° = 58° F. = the dew-point. Now the weight of vapour per cubic foot constituting saturation is given in Table A as 5·39 grains at 58° F., and 7·27 grains at 67° F., therefore the present degree of humidity is $\frac{5{\cdot}39 \times 100}{7{\cdot}27} = 0{\cdot}74$, or 74 per cent of saturation at 67° F.; or, as we say, 74° of humidity.

The two tables following give (A) the weight of a cubic foot of vapour at each degree Fahrenheit from 0° to 100°, or the weight that constitutes saturation, the temperature being the dew-point at 30 in. of barometric pressure, and (B) Glaisher's factors for all temperatures from 0° to 100° F.

A.—*Table of Tensions and Dew-points, or Weight of Vapour constituting Saturation at every Degree, from* 0° F. *to* 100° F.

Temp. °F.	Weight in Grains of a Cubic Foot of Vapour.	Temp. °F.	Weight in Grains of a Cubic Foot of Vapour.	Temp. °F.	Weight in Grains of a Cubic Foot of Vapour.
0	0·55	34	2·30	68	7·51
1	0·57	35	2·39	69	7·76
2	0·59	36	2·48	70	8·01
3	0·62	37	2·57	71	8·27
4	0·65	38	2·66	72	8·54
5	0·68	39	2·76	73	8·82
6	0·71	40	2·86	74	9·10
7	0·74	41	2·97	75	9·39
8	0·77	42	3·08	76	9·69
9	0·80	43	3·20	77	9·99
10	0·84	44	3·32	78	10·31
11	0·88	45	3·44	79	10·64
12	0·92	46	3·56	80	10·98
13	0·96	47	3·69	81	11·32
14	1·00	48	3·82	82	11·67
15	1·04	49	3·96	83	12·03
16	1·09	50	4·10	84	12·40
17	1·14	51	4·24	85	12·78
18	1·19	52	4·39	86	13·17
19	1·24	53	4·55	87	13·57
20	1·30	54	4·71	88	13·98
21	1·36	55	4·87	89	14·41
22	1·42	56	5·04	90	14·85
23	1·48	57	5·21	91	15·29
24	1·54	58	5·39	92	15·74
25	1·61	59	5·58	93	16·21
26	1·68	60	5·77	94	16·69
27	1·75	61	5·97	95	17·18
28	1·82	62	6·17	96	17·68
29	1·89	63	6·38	97	18·20
30	1·97	64	6·59	98	18·73
31	2·05	65	6·81	99	19·28
32	2·13	66	7·04	100	19·84
33	2·21	67	7·27		

B.—*Glaisher's Factors.*

Reading of Dry Bulb.	Factor the Product of which into the difference between the readings of the Dry and Wet Bulb Thermometer deducted from the former gives the Dew-point.	°F.	Factor.	°F.	Factor.
		36	2·50	69	1·78
		37	2·42	70	1·77
		38	2·36	71	1·76
		39	2·32	72	1·75
		40	2·29	73	1·74
		41	2·26	74	1·73
		42	2·23	75	1·72
10	8·78	43	2·20	76	1·71
11	8·78	44	2·18	77	1·70
12	8·78	45	2·16	78	1·69
13	8·77	46	2·14	79	1·69
14	8·76	47	2·12	80	1·68
15	8·75	48	2·10	81	1·68
16	8·70	49	2·08	82	1·67
17	8·62	50	2·06	83	1·67
18	8·50	51	2·04	84	1·66
19	8·34	52	2·02	85	1·65
20	8·14	53	2·00	86	1·65
21	7·88	54	1·98	87	1·64
22	7·60	55	1·96	88	1·64
23	7·28	56	1·94	89	1·63
24	6·92	57	1·92	90	1·63
25	6·53	58	1·90	91	1·62
26	6·08	59	1·89	92	1·62
27	5·61	60	1·88	93	1·61
28	5·12	61	1·87	94	1·60
29	4·63	62	1·86	95	1·60
30	4·15	63	1·85	96	1·59
31	3·70	64	1·83	97	1·59
32	3·32	65	1·82	98	1·58
33	3·01	66	1·81	99	1·58
34	2·77	67	1·80	100	1·57
35	2·60	68	1·79		

Mr. Glaisher has constructed also a series of elaborate and highly accurate tables, giving the expansion of dry air by heat, the elastic force of aqueous vapour in inches of mercury, the expansion of a volume of dry air when saturated with vapour, and the weights of a cubic foot of dry air, of vapour, and of saturated air, all calculated for the pressure of 30 inches of mercury, and for each degree Fahrenheit from 0° to 100°, together with empirical factors for correction of results at great altitudes, obtained by observations made during his balloon ascents. These, with full instructions for the use of the general tables, and the additions and corrections to be made in the results under certain circumstances, as when the differences between the readings of the wet and dry bulbs are considerable, are published by Taylor & Francis of Fleet Street, price 2s. 6d., and are indispensable to the regular observer, though the shorter tables given here will be sufficient when extreme accuracy is not necessary.

DEW AND FROST—FOG AND MIST

Evaporation, in nature, depends less on the temperature of the air than on its relative humidity and consequent capacity for taking up more moisture. It is therefore aided by winds which carry off the air as it tends towards saturation, and replace it by drier. Evaporation lowers the temperature of the air and of the surface soil, since all matters in passing from the solid to the liquid, or from this to the gaseous state, abstract heat from their surroundings, which they give off during the reverse transition. Thus a heavy fall of snow is attended by a perceptible rise of temperature, and the "raw" cold that accompanies a thaw is well known. Thus, too, is produced the refreshing coolness that follows a shower, or the use of the water-cart or hose in hot dry weather, and an east wind feels colder than another of the same temperature, and favours more the formation of ice, because its greater dryness increases evaporation from the exposed surfaces of the body and from sheets of water.

Temperature indicated by the Dry Bulb	Difference between the dry and wet bulb.															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Relative humidity. Saturation = 100.															
85	100	95	90	85	80	76	73	68	64	61	58	55	52	49	46	43
84	100	95	90	85	80	76	73	68	64	60	57	54	51	48	45	43
83	100	95	90	85	80	76	73	68	64	60	57	54	51	48	45	42
82	100	95	90	85	80	76	73	68	64	60	57	54	51	48	45	42
81	100	95	90	85	80	76	72	68	64	60	56	53	51	47	44	41
80	100	95	90	85	80	75	72	67	63	59	56	53	50	47	44	41
79	100	95	90	85	80	75	72	67	63	59	56	53	50	47	44	41
78	100	94	89	84	79	75	72	67	63	59	56	53	50	47	44	41
77	100	94	89	84	79	75	72	67	63	59	56	53	50	47	44	41
76	100	94	89	84	79	75	71	67	63	59	55	52	49	46	43	40
75	100	94	89	84	79	74	71	66	62	58	55	52	49	46	43	40
74	100	94	89	84	79	74	71	66	62	58	55	52	48	45	43	40
73	100	94	89	84	79	74	70	66	62	58	54	51	48	45	42	40
72	100	94	89	84	79	74	70	65	61	57	54	51	48	45	42	39
71	100	94	88	83	78	73	70	65	61	57	53	50	47	44	41	38
70	100	94	88	83	78	73	69	65	61	57	53	50	47	44	41	38
69	100	94	88	83	78	73	69	64	60	56	53	50	47	44	41	38
68	100	94	88	83	78	73	69	64	60	56	52	49	46	43	40	37
67	100	94	88	83	78	78	69	64	60	56	52	49	46	43	40	37
66	100	94	88	83	78	73	69	64	60	56	52	48	45	42	40	37
65	100	94	88	83	78	73	68	63	59	55	51	48	45	42	39	36
64	100	94	88	82	77	72	68	63	59	55	51	48	44	42	39	36
63	100	94	88	82	77	72	68	63	59	55	51	47	44	41	38	35
62	100	94	88	82	77	72	68	62	58	55	50	47	44	41	38	35
61	100	94	88	82	77	72	67	62	58	54	50	47	44	41	38	35
60	100	94	88	82	76	71	67	62	58	54	50	46	43	40	37	34
59	100	94	88	82	76	71	67	61	57	53	49	46	43	40	37	34
58	100	93	87	81	76	71	66	61	57	53	49	45	43	40	37	34
57	100	93	87	81	75	70	66	61	57	53	49	45	42	39	36	33
56	100	93	87	81	75	70	66	60	56	52	48	44	41	38	35	32
55	100	93	87	81	75	70	65	60	56	52	48	44	41	38	35	32
54	100	93	86	80	74	69	64	59	55	51	47	43	40	37	34	31
53	100	93	86	80	74	69	64	59	55	51	47	43	39	36	33	30
52	100	93	86	80	74	69	64	59	54	50	46	42	39	36	33	30
51	100	93	86	80	74	68	63	58	54	50	46	42	38	35	32	29
50	100	93	86	80	74	68	63	58	54	49	45	41	37	34	31	29
49	100	93	86	79	73	67	62	57	53	49	45	41	37	34	31	28
48	100	93	86	79	73	67	62	57	52	48	44	40	36	33	30	
47	100	93	86	79	73	67	61	56	51	47	43	39	36	33	30	
46	100	93	86	79	78	67	61	56	51	47	43	39	35	32	29	
45	100	92	85	78	72	66	60	55	50	46	42	38	34	31	28	
44	100	92	85	78	71	65	59	54	49	45	41	37	34	31	28	
43	100	92	85	78	71	65	59	54	49	45	41	37	34	31	28	
42	100	92	85	78	71	64	58	54	49	44	40	36	33	30	27	
41	100	92	85	77	70	64	58	53	48	43	39	35	31	28		
40	100	92	85	77	69	63	57	52	47	42	38	35	31			
39	100	92	84	77	69	63	57	51	46	42	38	34				
38	100	91	83	75	68	62	56	50	45	41	37					
37	100	91	83	75	68	61	55	49	44	39						
36	100	91	82	74	67	59	53	47	42							
35	100	90	80	72												
34	100	89	79	72												
33	100	88	78	70												
32	100	87	75													

Fig. 4.

Dew is the precipitated vapour from the lowest stratum of the air chilled by the rapid radiation from the earth under a clear sky. It is not formed when radiation is checked by overhanging clouds, or a strong wind maintains a constant renewal of the air. *Hoar frost* is not frozen dew, but ice deposited under like conditions, save as regards temperature, just as snow is not rain frozen in its fall, but the form assumed by cloud vapour precipitated at low temperatures.

Fog and Mist.—The formation of fog, unlike that of dew, is favoured by a moderate movement of the air, and indirectly by irregularity of the surface of a district. It results from the rapid cooling of large masses of air below their dew-points, the excess of vapour being condensed, but not precipitated as rain or snow. *Fog* is therefore formed by the same causes as when intensified produce rain, (1) the mingling of volumes of warm humid air and cold dry air (provided the temperature of the mixture be below its dew-point), (2) the sudden chilling of vapour-laden air when it (*a*) impinges on cold hill-tops or cliffs, or (*b*) passes over land cooled by evaporation, as wet clay soils, or (*c*) the surface of lakes (provided the water be colder than the moving air). *Mists* formed over running streams in frosty weather are, however, due to the condensation of the vapour rising from the warmer water, and those in valleys and over damp meadows are caused in many instances by the colder, and therefore heavier air from the higher lands around flowing down and condensing the vapour in the warmer air in the valley, which, if there be little or no wind, may gradually assume the appearance of a lake of white mist.

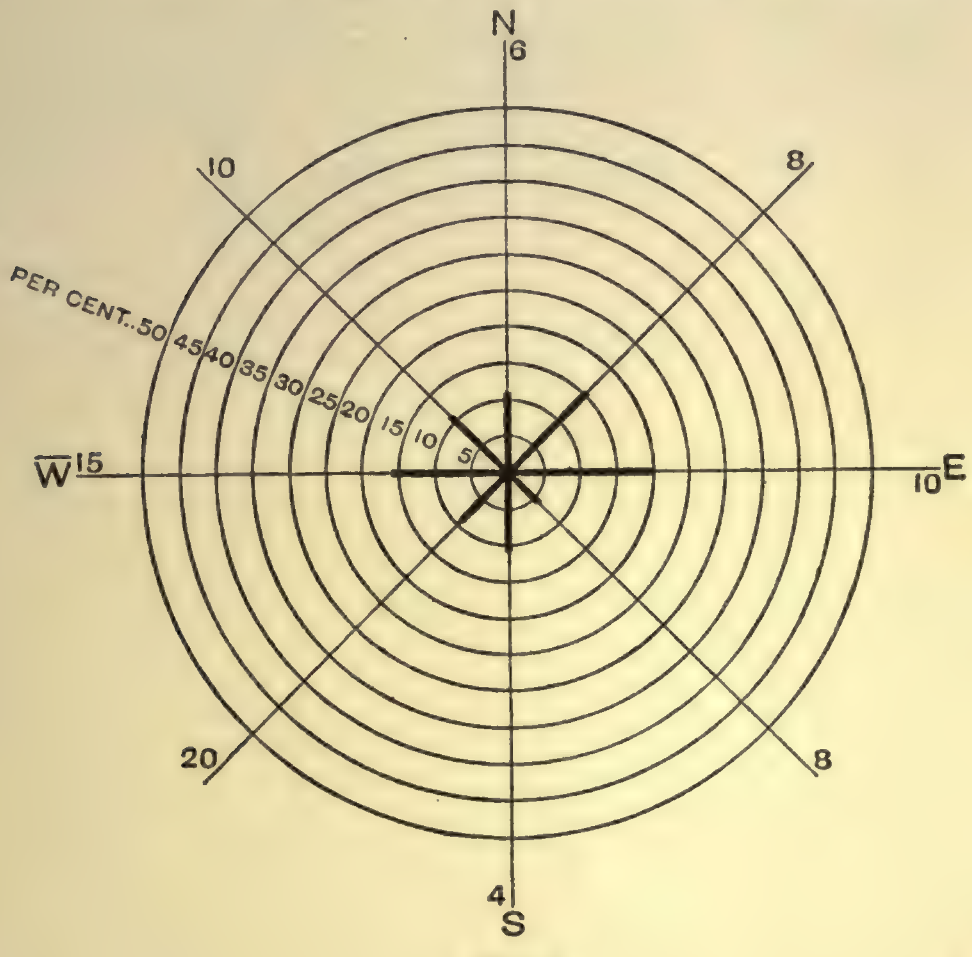

Fig. 5.

Though fog and mist, which differ only in the size of the coalescing drops of water, may, like dew, saturate the clothing of persons exposed to them, they are by no means necessarily indicative of dampness of site. No such suspicion attaches to those capping the summits of hills and elevated moorland of scantily covered rock, or veiling the cliffs and headlands of the western and southern coasts, nor to fogs to which the heights along the course of rivers are exposed, even more it may be than the low lands beneath; but the case is totally different when they mark the sites of ponds and water-courses that have disappeared through drainage, or haunt low-lying lands where the ground-water is near the surface.

Clouds consist of condensed vapour identical with fog or mist, but in the highest regions of the atmosphere they are often composed of prismatic crystals and spiculæ of ice.

The lowest levels at which they float range from about 2500 feet in these islands to 10,000 feet in the tropics. Howard's classification of clouds is adopted universally—

A, Cirrus
B, Stratus
C, Cumulus
A + B, Cirro-stratus.
A + C, Cirro-cumulus.
B + C, Cumulo-stratus.
A + B + C, Cumulo-cirro-stratus or nimbus.

Cirrus.—Feathery, streaky clouds at the very highest altitudes, probably composed of ice particles, moving slowly and usually in a direction opposite to that of the lower air. Generally a sign of wind and the forecast of a change of weather.

Cirro-stratus, formed by the condensation of cirrus, appears as a network or as "ribs" stretching across from the horizon on one side to that on the other, but gradually coalescing as it sinks, it ultimately spreads over the whole sky of a uniform density. It indicates the approach of rain.

Cirro-cumulus, also a high cloud, though at a somewhat lower level, is more flocculent and humpy, the rounded masses being often detached. It is popularly known as the "mackerel sky."

Stratus is a cloud defined by Howard as "a widely extended continuous horizontal sheet, increasing from below upwards." It is fairly uniform in thickness and hue. Howard called it "ground fog," which it is, lifted to a higher level. It is a fine-weather cloud, appearing in the evening and morning, to vanish before the warmth of the sun. Another cloud, of no great altitude and mostly seen in fine weather, is the *cumulus,* resulting from the rapid condensation of moist air on rising to cooler strata of the atmosphere. It is massive, opaque, and with sharply-defined outlines, rounded above or resembling a range of mountain-peaks, white, and popularly compared to wool-packs when the sun shines on it, but when it conceals the sun it is dark often with gold or silver margins. Its base is almost always flat or horizontal, marking a stratum of warmer air that takes up the condensed vapour.

Cumulo-stratus is a common form of cloud, often covering great part of the sky. It is a mixture of the three primary forms, and marks a transition to the *nimbus* or rain cloud; the flat base and alternate strata of darker and lighter hue indicate alternations of warmer and colder air. It soon passes into the *cirro-cumulo-stratus,* in which all three primary forms are blended, and is pre-eminently the cloud of rain and storm. When approaching from the horizon the upper border may be sharply outlined, while rain is seen falling from the under, but when overhead all definition and distinctions are lost in the rain, into which the under-surface passes.

RAIN AND SNOW

Rain is the result of the sudden condensation of vapour, or, more correctly, of finely divided particles of water, contained in masses of warmer air in the form of fog or cloud, when these come in contact with colder air or impinge on the cold summits of mountains. There are three ways in which this may occur:—(1) The ascent of a current of damp air into the higher regions of the atmosphere, (2) the contact of warm damp air with the colder earth of hills and mountain ranges, and (3) the mixture of masses of hot and cold air. The first is perhaps the most certain in its result, provided only the essential condition of such a warm humid atmosphere, as is rarely met with in this climate, be present. It is, however, in constant operation in the tropics, where it is the chief, often the sole cause of the copious rainfall in insular and low-lying regions. The second is that by which most of the rain in the temperate zones is produced. In Europe and America alike the heaviest rainfall is found on the western coasts, fanned by the moist and warm south-western gales from over the oceans; and since these shores are in Great Britain, Scandinavia, and North America the more mountainous, the warm vapour-laden air is forced upwards, when the first of these causes, the cold of the higher zones of the atmosphere, is superadded to the second, which alone would scarcely suffice to produce the heavy downpours so frequently observed in such districts, while the latent heat set free in the condensation of the vapour tends to maintain the mildness of the winter, as the amount of evaporation does to moderate the heat of summer. The third cause is, as Dr. Hann has demonstrated, far less efficient than was formerly imagined.[1]

The average rainfall in England and Wales is 33·76 in., in Scotland 46·56, and in Ireland 38·54. But while in the eastern counties of England it is only 25 inches, in the hilly or mountainous and moorland districts of Devon, Cornwall, Wales, the Pennine range, and Cumberland, it varies from 40 to 80 inches, in some localities exceeding 100. The like difference is observed between the eastern and western counties and shores of Scotland, and, though to a less extent, in Ireland. The heaviest rainfalls in England and Wales are in the Lake district, around Snowdon, and over a small area in Carmarthen, and in Scotland in the Isle of Skye and on the opposite mainland from Ben Nevis to Loch Linnhe. The extremes for the whole island are 15 inches at Thetford in Suffolk, and 145 at Seathwaite in Cumberland. But there are marked differences at the same places in different years, as at Plymouth, where the extremes hitherto recorded have been 45 and 100, and at Exeter 30 and 90, while, owing to local orographical conditions, there are spots in the areas of the heaviest rainfall where the mean rivals that of the lowest, *e.g.* at Sidmouth in Devonshire it is 32, and at Cockermouth in Cumberland only 22, though but a few miles distant from Seathwaite where the mean is 145 inches, and the highest in the United Kingdom. There is no relation between the rainfall and the humidity of the air, the latter depending on the nature of the soil, as may be seen in the following table, giving the temperature, rainfall, number of rainy days, humidity, and nature of the soil at a number of English health resorts. The independence of rainfall and humidity is well illustrated by the contrast presented by Falmouth and Cromer, the rainfall at the former being 60 per cent greater, but the humidity 5 per cent less than at the latter:—

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[1] He calculated that the admixture of equal volumes of saturated air at 77° F. and 32° F., containing respectively 10·0 and 2·1 grams of vapour in the cubic foot, would give a mean temperature of 58·7° F., not 54·5°, owing to the liberation of 0·093 units of heat in the condensation of 1·5 grams of vapour in the cubic foot, of which 0·9 grams would be taken up again, leaving only 0·6 grams to be thrown down, as a rainfall from a column 1000 feet high of not more than 0·048 inch; and such a difference as 77° F. and 32° F. is itself in the highest degree improbable.

[TABLE

Place.	Subsoil.	Mean Winter Temperature in deg. F.	Mean Summer Temperature in deg. F.	Mean Daily Range in deg. F.	Mean Annual Rainfall in inches.	Rainy Days.	Humidity per cent.
Regent's Park	London clay	41·6	56·9	13·8	25·16	164	80
Margate	Chalk	41·8	56·4	10·9	22·98	165	81
Lowestoft	Gravel	40·8	54·8	11·4	24·09	173	83
Cromer	Cragland blue clay	40·6	55·4	12·0	27·73	154	85
Scarborough	Loam on clay	40·8	54·1	10·0	26·68	195	83
Hastings	Sand on sandstone	42·2	57·0	11·8	29·26	137	82
Eastbourne	West-end chalk, east loam	42·2	56·2		29·53	165	
Brighton	West-end clay, east chalk	42·5	57·1	11·2	30·43	163	78
Southsea	Bagshot sand and clay	42·7	55·2	13·8	26·39	173	82
Ventnor	Lower greensand	44·2	57·7	10·5	28·33	167	80
Weymouth	Sand, shingle, clay	43·5	56·8	10·3	27·61	162	81
Teignmouth	Marl, in parts sand	43·8	57·0	12·4	32·28	169	82
Torquay	Limestone	43·5	55·9	10·8	31·72	177	80
Falmouth	Slate on quartz	44·9	57·0	9·5	43·49	204	81
Ilfracombe	Shales on sandstone	44·9	57·0	8·4	31·53	191	85
Llandudno	Limestone	42·7	55·2	10·1	27·52	175	79
Guernsey	Granite	45·5	57·6	9·1	33·28	192	85

These averages are taken from the records of the Meteorological Society from 1882 to 1888 inclusive, except for Brighton, where they have been contributed by a local observer during the years 1879 to 1892.

The seasonal distribution of the rainfall in the eastern and western counties of England and in London is shown below:—

Order of Months in the East of England.	Average Rainfall in Inches 1813 to 1872.			Order of Months in the West of England.
	England East.	London (slightly different).	England West.	
August	2·84	2·26	5·25	November
November	2·83	2·28	4·97	October
October	2·71	2·74	4·42	December
July	2·57	2·32	3·95	August
September	2·55	2·35	3·72	January
May	2·11	2·07	3·54	September
June	1·95	2·01	3·46	July
January	1·89	1·91	2·86	February
December	1·60	1·93	2·84	{March}
February	1·59	1·52	2·84	{June}
April	1·40	1·66	2·59	{April}
March	1·40	1·52	2·59	{May}
	25·52	24·55	43·03	

MEASUREMENT OF RAINFALL

Rain Gauge.—The best form is that known as the Snowdon gauge, which consists of a glass funnel, having a diameter of 8 inches, and therefore an area of 50 square inches, let into a deep copper cylindrical vessel, having a rim inside just below its upper margin on which the funnel may rest. Within this is a glass cylinder, into which the tube of the funnel dips, provided with a lip for convenience in emptying it. To retain snow which might be blown out of the funnel a second cylinder of copper, 8 inches in diameter, and open at both ends, is mounted on the rim of the other, so as to form a wall several inches high around it. It should have a flange on its lower end to steady it. The water or the melted snow is, when collected, once a day or oftener in hot weather, measured in an accurately graduated glass, unless the receiver itself be graduated for the purpose. But the narrower the measuring glass the more accurate will be the estimation. Thus, if the diameter of the measure be 2½ inches its area will be 5 square inches, or one-tenth that of the funnel, and each inch and tenth of an inch on it will represent a depth of 0·1 inch and 0·01 inch of rain. The gauge should be fixed at a height of 1 to 4 feet from the ground in an open situation, free from all eddies, with no building or other object subtending an angle of 20°. Theoretically the elevation should make no difference, but in practice it is found that a gauge placed on a terrace or a roof shows a less amount of rain owing to the up-current of air produced by the deflection of the wind impinging on the face of the wall.

This is the explanation of the apparently lesser rainfall on roofs and terraces than on the ground below; but when the difference of elevation amounts to hundreds or thousands of feet the phenomenon is real, for cooler raindrops or snow, in passing through warmer, nearly saturated strata, or those in which the vapour is already condensed as cloud or fog, condense the gaseous and precipitate the condensed moisture, increasing rapidly in bulk as they fall.

In London and the eastern counties a fall of 1 inch in the twenty-four hours is rarely exceeded, though 3·12, 3·5, and 4·6 inches have been collected within a few hours on some occasions, and 4·3 and 5·3 in the western shores.

The bulk of snow depends on the size and grouping of the crystals, but roughly a foot of snow corresponds to an inch of rain. Alleged falls of 4 or 6 feet are really the effects of drifting.

The question of the origin and formation of hail, whether of the true and hard or the soft kind, is one that has never been satisfactorily solved.

WINDS

Though we can no longer assent to the proposition that "the wind bloweth where it listeth," we are not yet in a position to determine, much less to predict, "whence it cometh and whither it goeth," but we can watch, and to some extent anticipate its progress. Winds are the effects of disturbances of equilibrium, constantly proceeding in the freely mobile atmosphere; the causes of these disturbances being unequal densities due to unequal distribution of temperature and vapour, aided by physical and other factors, and are general or local in their action. Among the general are the permanently higher temperature of the equatorial zone and the cold of the polar regions, the annual alternation of summer and winter in the northern and southern hemispheres due to the obliquity of the earth's axis to the plane of its orbit, and consequently the greater or less angle of incidence of the sun's rays whereby one hemisphere is always warmer or colder than the other, and the diurnal cycle of day and night due to the rotation of the globe on its axis, exposing successive longitudinal segments of its surface from west to east to the influence of the solar rays, the effect of which in the diurnal range of temperature is more marked in that hemisphere which is for the time being the warmer; while among the local conditions are the distribution of land and water, with their unequal capacity for absorption and radiation of heat, and the evaporation from the ocean, tending by the addition of aqueous vapour to lower the density and pressure of the atmosphere; the influence of warm and cold ocean currents which, having a like origin with those of the atmosphere, are deflected in all directions by the shores of the continents, and a similar, though less absolute, obstacle presented to atmospheric currents by mountain ranges, which deflect them to some extent, but exert a more powerful action in cooling them and precipitating their moisture as they impinge on their summits.

The velocity of the rotation of the globe being greatest at the equator and diminishing towards either pole, the upper and lower perpetual currents from the equator to the poles, and from the poles to the equator, are deflected towards the south-west or north-east as they pass from zones of greater velocity to those of lesser, or *vice versâ;* but these, as well as the secondary and directly dependent phenomena of trade winds and monsoons, belong rather to the field of physical geography than to the apparently fortuitous and variable phenomena of weather and climate with which we are concerned, and in which local conditions play so important a part.

In the rotation of the globe on its axis, the atmosphere, being less coherent than the earth, tends to lag behind; consequently in the northern hemisphere winds blowing from the north deviate towards the west and assume a north-easterly direction, while southerly winds become south-west. In the southern hemisphere the resultant of these forces will obviously be the converse of this, and the direction of the wind round an area of low pressure, which in the northern hemisphere is the reverse of that of the hands of a watch, will in the southern be with them, and that round one of higher will be with the hands in the northern, and against them in the southern hemisphere; the definition of cyclones and anticyclones commonly given and based on the order in the countries of Europe and North America, being reversed in this particular in those south of the equatorial zone. Hence Buys Ballot's law, which may be shortly stated thus:—

"Stand with your back to the wind—then in the northern hemisphere the barometer will be lower on your left, and in the southern on your right." Which is as true of mean pressure and winds, as it is of the temporary phenomena of storms at sea for which the Dutch professor propounded it.

The general complex of remoter consequences of the factors already enumerated is manifested in the vertical rotation of the atmosphere over limited areas, the vortices, or more accurately, helices and antihelices travelling in these latitudes from west to east, with a tendency, for the reasons already given, to deviate in a north-easterly direction. They are of two kinds, known as cyclones and anticyclones, the barometric pressure in the cyclone being lowest in the centre and rising rapidly towards the circumference. The area covered is relatively small, the movement of the air is centripetal and helicoidal, and from right to left, or as it is generally expressed, in a direction opposite to that of the hands of a watch, its velocity being directly proportioned to the abruptness of the transition from low to high pressure, or as it is called, borrowing a term from engineering, the steepness of the gradient. The pressure being lowest in the centre cyclones are often spoken of as "depressions." In the anticyclone all these conditions are reversed; the atmospheric pressure is highest in the centre, the outward gradient gentle, the area covered large, the movement of the air centrifugal, antihelicoidal, and from right to left, or in the same direction as the hands of a watch, while it is, owing to the lesser gradient, marked by a less velocity than that in the cyclone, which in the popular mind is generally associated with the notion of storms. When the "depression" or centre of a cyclone passes by to the north of any place the wind "veers," that is, changes as from S.E. through S.W.W., but if it pass by on the south the wind "backs," or changes in the opposite order.

The cyclone is characterised by high winds, rapid change, and more or less cloud and rain, lowering the temperature in summer, but raising it in winter. The anticyclone, on the other hand, moves slowly, and may even remain stationary for days, or sometimes weeks; it is attended by calm, clear weather, therefore, hot and dry in summer, but dry cold and frosty in winter; there may, however, be fogs, mostly on its border during cold weather. Though neither is restricted to any season, cyclones occur with greater frequency and severity between November and March, the period of storms, those in the summer being as a rule of less intensity, that is, the velocity of the wind is generally less in summer than in winter. Equinoctial gales are, as the records of the meteorological office prove, creations of the popular imagination, in northern Europe at any rate. The stormy season closes indeed with March, but rarely sets in before November, while, as every seaman knows, the maximum of frequency and severity is maintained between Christmas and February.

The helicoidal rather than cycloidal movement of the air in these vortices explains the fact that winds, when of moderate velocity, exhibit the character as regards temperature and humidity of the regions whence they appear to, and really do come; and the apparent paradox that in cyclones of steep gradient there often seems to be little or no relation between the quarter whence they appear to blow and the character usually associated therewith, their apparent direction being, in fact, an accident of their near approach to a cycloid, and of the part of their orbit encountered at the particular time and place. Such cyclones approximate to the extreme type with the minimum of area, and maximum of gradient and velocity known as a whirlwind, or in the tropics, a typhoon.

The countries of western Europe are at a disadvantage in being unable to watch the approach of cyclones, until they are already upon them, whereas those of central and eastern Europe and the eastern States of America receive intimation of coming storms from the chains of meteorological stations to the west for many hundreds or thousands of miles. From the information received from these stations the areas covered by cyclones or anticyclones at any given hour are mapped out at the national meteorological offices by concentric series of isobars, the atmospheric pressure, the direction and velocity of the winds, and the readings of the thermometer, being indicated on the maps, and other facts as rain, fog, etc. stated below, as may be seen daily in the *Times*.

ANEMOMETRY

Direction.—The vane, a simple rectangle, must be put up where it will be unaffected by eddies, whether horizontal or oblique, and adjusted to the true meridian, for the needle at the present time points west of the north, 19° in the extreme S.E. of England, to 25° in the N.W. of Ireland, the lines of equal declination running N.N.E. and S.S.W. It is sufficient to register the wind under the eight-quarters and half-quarters, N., N.E., E., S.E., S., S.W., W. and N.W., but any change during the day must be noted.

Pressure is closely connected with the velocity, but cannot be inferred from it as recorded by the anemometer, since that instrument indicates only the mean of the period under observation, and the destruction wrought by winds is the result of sudden gusts or blasts during which, it may be for minutes only, much higher velocities and pressures are attained. The anemometers of Osler and of Cator indicate and record the pressure exerted by the wind on plates by tracings on a drum. Cator's is worked by levers, Osler's by springs, which are more liable to be deteriorated by exposure. The readings, moreover, vary with the size of the plates, for which the customary square foot is probably insufficient.

Velocity.—Dr. Robinson's and Casella's are most used. In the former the wind is received on four cups which work a dial; the larger the cups the more correct the readings.

It was formerly the practice to assume that the register indicated one-third of the true velocity, but Professor Stokes found with Robinson's anemometer, as used by the Royal Meteorological Society, having cups 9 inches in diameter, on arms 2 feet long, the factor to be 2·4. Sir F. James gives the formula, $P = v^2 \times 0{\cdot}005$ for calculating the pressure from the velocity, v being the velocity in miles per hour, and P the pressure in lbs. per square foot, the pressure varying as the square of the velocity.

Beaufort's scale used in the Royal Navy is adopted by the Meteorological Office, and Schott's, which differs chiefly in the lower velocities, is employed by the Germans and Scandinavians.

Velocity of Wind according to Beaufort and Schott.

Force.	Velocity in Miles per Hour.			
	Beaufort.		Schott.	
0	Calm	3	0	Very different.
1	Light air	8	1	
2	Light breeze	13	4	
3	Gentle ,,	18	10	
4	Moderate ,,	23	17	Approximately the same.
5	Fresh ,,	28	24	
6	Strong ,,	34	32	
7	Moderate gale	40	40	
8	Fresh ,,	48	48	
9	Strong ,,	56	56	
10	Whole ,,	65	67	
11	Storm	75	82	
12	Hurricane	90	100	

But for observations on land, unfettered by nautical terms and symbolic numbers, the table following will be preferable, and it is believed more accurate:—

Velocity and Pressure of Wind.

Miles per Hour.	Feet per Minute.	Feet per Second.	Pressure (direct) in lbs. per Square Foot.	Description.
1	88	1·47	·005	Hardly perceptible.
2	176	2·93	·020	Just perceptible.
3	264	4·4	·044	
4	352	5·87	·079	Gentle breeze.
5	440	7·33	·123	
10	880	14·67	·492	Pleasant breeze.
15	1329	22·	1·107	
20	1760	29·3	1·968	Brisk gale.
25	2200	36·6	3·075	
30	2640	44·	4·428	High wind.
35	3080	51·3	6·027	
40	3520	58·6	7·872	Very high wind.
45	3960	66·	9·963	
50	4400	73·3	12·300	Storm.
60	5280	88·	17·712	Great storm.
70	6160	102·7	24·108	
80	7040	117·3	31·488	Hurricane.
100	8800	146·6	49·200	

Weather Charts.

In the compilation of weather-maps the direction of the winds is indicated by arrows, and the force by the number of pinnæ from 1 to 5 :

Symbol.	Force.	Velocity.	
		Miles per Hour.	Metres per Second.
⸝——→	1, 2	0 to 9·0	0 to 4·0
>——→	3, 4	9·1 to 22·5	4·1 to 10·0
>→——→	5, 6	·6 to 40·5	10·1 to 18·0
>→→——→	7, 8	40·6 to 67·5	18·1 to 30·0
→→——→	9, 10	67·6 and upwards	30·1 and over

The representation of the mean velocities and directions of prevailing winds is very unsatisfactory. Wind roses are perhaps the best and simplest; the percentages of the observed directions being indicated by the relative length of the rays in a diagram of the compass, and the mean velocity or force (pressure) of each shown by a number at the extremity of the ray. The rays should be divided into ten equal segments by a series of concentric 5 per cent circles, leaving the intermediate units only to be determined by measurement or by the eye. (See Fig. 5, p. 61.)

INFLUENCE OF METEOROLOGICAL CONDITIONS ON HEALTH

It was one of the many apophthegms of the great Max von Pettenkofer, at once wise and witty, that "we do not leave home for change of air, but for change of *soil*," and it is absolutely true. The air, as air, is in perpetual flux, but the climate, in the local and more limited meaning of the word, is determined by the soil even more than by elevation and aspect, which are second only to it in importance. On these with the character of the soil as regards its nature, permeability, retentiveness of water, depth of subsoil, rise and fall of ground water, if present, or its absence, the surface contour, presence or absence of trees or herbage, its drainage and cultivation or waste character, and even on its colour, as affecting its absorption or reflection of light and heat, depend the amount of rainfall, the dampness or dryness of the site, the humidity of the air, the tendency to fogs, and to some extent the temperature of the place. When, in fact, one hears that two places within a few miles of one another, or the two extremities of some seaside health resort, have different "airs," it will always be found that it is the soils that differ, and that in this lies the explanation of the difference in the local climates.

A full examination of the influence of soil on climate belongs rather to physiography, and we must limit our observations to its immediate bearings on meteorological conditions. Gravels, sands, and chalk are among the most pervious to air and water; *if deep*, they will be dry and warm and free from fogs, except sea fogs, and such as, forming on hill tops and cliffs, do not betoken dampness of site. But a shallow surface soil of this kind resting on an impervious stratum will accumulate a sheet of ground water, oscillating with the amount of rainfall for the time being, and sometimes rising almost to the surface. If by a river side the ground water will closely follow its ebb and flood, and in a hollow the soil will be waterlogged. Capillary attraction and evaporation will keep such localities damp and foggy. Impervious and yet retentive soils, as stiff clays and marls, do not admit of ground water,[1] but are cold, damp, and foggy, the rain lying long on the surface as large puddles which evaporate slowly, or sinking a few inches into the cultivated or made soil on the surface. In towns, however, with the entire area well sewered and paved, clay soils may be fairly dry, and for low-lying riverside dwellings their impermeability is a distinct advantage. Impervious and non-retentive rocks are of course the driest of all.

High Altitudes.—The factors that go to make up the characteristic climate of high altitudes are the low atmospheric pressure, the lesser amount of oxygen in a given volume of air, the lower temperature and greater dryness of the air, and the greater intensity of the solar rays. Though the experimental methods adopted to determine the nature of the changes in the blood induced by the long-continued respiration of such rarefied air have been subjected to severe criticism, there can be no reasonable doubt as to the increase in the number of erythrocytes, the amount of hæmoglobin, and the capacity for absorbing oxygen, together with the greater depth and volume of the respirations; while stimulation of the evaporation from the body and the metabolic processes aid the general nutrition, and the influence of the solar rays in a clear diathermic atmosphere cannot but be highly beneficial.

The effect of dampness of soil on the prevalence of phthisis, though indisputable, is but indirect; combined with humidity and fog, with cold winds and chill, it is apt to induce catarrhal states of the respiratory mucous membrane, rendering it more vulnerable to the attacks of the tubercle bacillus, especially if the domestic and other conditions of life be more or less insanitary; but simple exposure to cold, and even to wet, as in a life passed in the open air, tends to harden the system against such accidents, as is seen in the extraordinary exemption from phthisis and the diseases of the respiratory organs enjoyed by fishermen, and in a less degree by agriculturists, and in the results of the out-door treatment of persons already phthisical.

Cold and damp localities are, however, conducive to rheumatic affections, though acute rheumatism, or rheumatic fever, really a different disease, seems to be more prevalent in places exposed to cold *dry* winds, probably from the liability to sudden arrest of the perspiration incident thereto. So long as the normal temperature of the blood is maintained by unchecked perspiration, and the tension of the vascular system by imbibition of water, the most intense heat in a dry atmosphere can be borne without ill effects, as in Colorado, but the failure to maintain either of these conditions is speedily followed by one or other form of heat-stroke.

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[1] The so-called "land springs" met with in heavy clays are seams of gravel which, collecting storm waters along their line of outcross, act precisely as "agricultural drains," and are a serious annoyance when intersected by the cellars or basements of houses.

Malarial diseases, so-called, can no longer be ascribed to meteorological conditions, since it has been proved experimentally that, so long as the body is protected against the attacks of the *anopheles*, men may reside with impunity in the most "pestilential" districts, even sleeping on the ground exposed to the night air, while the disease may be induced artificially in the healthiest localities by the bites of infected insects.

The seasonal prevalence of diseases of the respiratory organs is clearly attributable to the weather conditions of cold and damp, or the chilling effects of cold dry winds on the skin and bronchial mucous membranes. The annual recurrence of diarrhœal affections, especially among infants, in the third quarter of the year, so soon as the ground temperature at a depth of two feet or thereabouts reaches and continues at or over 60° F., is easily explained by the resuscitation to activity of certain pathogenic saprophytes to which these diseases are due, and to the changes effected by their means in milk and other foods. But the annual curves exhibited by other specific infectious diseases present problems of greater complexity. For the purpose of investigation of their etiology we must distinguish between those that, though propagated by direct personal infection, are originally referable to the attacks of bacteria having an independent and extra corporeal existence in the outer world, that is, in the soil or the water, and those that are purely parasitic, the bacteria being unable to maintain an active existence, and to perpetuate their kind out of the human body. These questions, together with those involved in the cyclical recurrence of waves of greater and lesser epidemicity, have been already discussed in the article on "Epidemiology" (vol. iii.), and we shall restrict ourselves to a few remarks on meteorological aspects of the seasonal prevalence or annual curves presented by these two groups. Typical examples of the former are enteric fever, and diphtheria among endemic diseases, and cholera which, endemic in a comparatively narrow area of the surface of the globe, occurs as an epidemic only in other regions either annually, or at longer or at indefinite intervals; and of the latter measles, scarlatina, and small-pox, though the occurrence and recurrence of this last is greatly controlled and interfered with by the more or less general practice of vaccination. The meteorological conditions of the former are twofold: (1) those affecting the extra corporeal existence and activity of the microbe itself; and (2) those that influence the susceptibility of the human being; whereas with the latter the influence of meteorological conditions can be exerted indirectly only, that is, by rendering the individual more vulnerable or less resistant to infection. Those acting on the bacteria are the optimum temperature and humidity of the soil for each kind, whereas with those rendering the individual more susceptible, we have to consider the personal equation. The concurrence of the two is necessary in the former case. Thus in India, where the temperature is always sufficiently high, cholera waits for the recurrence of the rains to provide the other condition, and as the seasons are reversed in Lower Bengal and in Southern India the annual recurrences of cholera are so too; whereas in Europe it is the higher temperature of late summer and autumn that is necessary for the development of an epidemic when the germ has been introduced. Enteric fever finds the requisite conditions in autumn only, and the curve rises with the utmost regularity in August, to decline in December with the approach of winter. The conditions of diphtheria are somewhat complicated by the personal element, the highest mortality being in November and December, when catarrhal affections of the throat increase the susceptibility to infection by a disease that attacks the naso-pharynx, tonsils, and larynx. Measles presents two annual waves, the maxima being reached in June and December, but it is a remarkable fact that while in England and on the continent of Europe the winter wave is the higher, in Scotland, Scandinavia, and in Hamburg the order is reversed. Scarlatina in Europe is most prevalent and fatal in October, and least so in May and June, but for reasons hitherto unexplained, the maximum in New York is as constantly reached in May. The social conditions may in some cases be themselves dependent on the meteorological, as when the weather tempts to an out-door life and free ventilation of the dwelling, or drives the population into their houses and to neglect of ventilation, but the causes of the seasonal prevalence of the purely infectious diseases are too complex and various to admit as yet of any satisfactory explanation.

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Metritis. *See* Uterus.

Microcephalus.—This is a condition characterised by an abnormally small head, with, in addition, a peculiar shape of the cranium. The forehead is unduly small and receding, the occiput is flat, and the vertex somewhat pointed. The various parts of the brain are unnaturally small. Some years ago operative measures were tried with the view of remedying this condition, but these were found of no avail. As Shuttleworth says, "Premature synostosis of the sutures of the skull is, in our experience, rare, so that operative measures founded on this hypothesis are illogical." The condition derives importance from the state of mental enfeeblement associated with it, and is further considered in the article on "Mental Deficiency" in this volume.

Micromegaly.—This is a rare condition, and can only be classified as a pathological curiosity. It was first described by Hutchinson and Hastings (*Lancet*, ii. 1896) as a remarkable condition of "mixed premature and immature development." It is the antithesis of acromegaly. The name of micromegaly was later suggested, and the condition has been regarded as a disease of that part of the nervous system presiding over nutrition. The disease manifests itself by an excessive size and prematurity of some parts or functions of the body, with swellings and immaturity of others.

Microphthalmos.— As the term indicates, this is a condition characterised by small size of the eyes. It is the antithesis of myolophthalmos, in which the eyeballs are unnaturally large. As might be expected, in the one case the eyes appear to be small, somewhat flat, and retracted in the sockets, while in the other they are unduly prominent, an excessive amount of sclera is visible, and the condition suggests exophthalmic goitre. As a rule, the diminution or enlargement is shared by all the coats of the eye. Thus we have the terms microcornea, macrocornea, etc. The pathology of these conditions is unknown. Vision may be normal, but is not unusually slightly defective. No treatment is called for.

Micro-organisms.

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(SEE also various Special Diseases and the articles on ENZYMES, IMMUNITY, POST-MORTEM EXAMINATION, SUPPURATION.)

THE term micro-organisms, though unscientific, has been used very generally, especially by medical men, to include the lowest forms of animal and vegetable life concerned in the production of putrefaction, fermentation, and disease. Micro-organisms thus defined include Protozoa, Hyphomycetes, Blastomycetes, Streptothrices, and Bacteria. By far the greater number of disease processes are attributable to the agency of pathogenic bacteria.

PROTOZOA

The Protozoa comprise the lowest forms of animal life. Bütschli defines them as organisms composed of a single cell, or groups or associations of cells of similar structure which behave physiologically, *i.e.* with regard to their mode of nutrition, metabolism, irritability, and motility, like typical unicellular animals. The same author divides the Protozoa into four classes: *Sarcodina, Sporozoa, Mastigophora,* and *Infusoria.*

I. *Sarcodina* comprise all Protozoa which when active and motile move by simple protoplasmic streaming, or by means of movable protoplasmic processes of varying shape, the form of the organism undergoing considerable modifications. Food particles are taken up directly into the organism. Reproduction occurs through simple division.

II. *Sporozoa* are parasitic Protozoa which multiply through division or budding into a variable, at times large number of capsulated reproductive bodies (so-called spores). The plasma of these spores may in turn divide into a number of germs. Recent investigations have shown the existence of a sexual mode of multiplication in a number of Sporozoa.

III. *Mastigophora* are Protozoa which during their most active period of existence are furnished with one or more cilia, and are actively motile.

IV. *Infusoria* comprise the highest and most diversified forms of Protozoa. They are permanently or during a greater part of their existence supplied with numerous cilia which serve for feeding besides locomotion.

All of these classes comprise parasitic forms, the group of the Sporozoa being the most important and highly adapted to a parasitic existence in different organs, or within certain cells. Whereas certain forms like the malarial parasites are extremely minute, others (Gregarines) may be visible to the naked eye. Nuclear division may be direct or accompanied by karyokinesis. The nucleus may be exceedingly small and single, as in the malarial parasite, or there may be several nuclei, macro- and micro-nuclei, as in Infusoria. Protozoa may be amœboid or of constant form, or they may exhibit amœboid movement in one stage of their development, and a great variety of form during other periods of their growth. In some stages the protoplasm may be scarcely differentiated, in others highly specialised. The protoplasm may be differentiated into a hyaline ectoplasm and granular endoplasm. Some forms possess a cuticula and apparently a contractile sheath. Some move by pseudopodia, others by a flowing motion, others again by cilia and undulating membranes. The protoplasm may contain contractile and stationary or digestive vacuoles, and starch-like and fatty granules. Whereas some live within cells as parasites (Hæmocytozoa of malaria), others directly ingest the cellular elements of their host (Amœba coli). The policystic Gregarines possess anchor-like organs by which they attach themselves to the cells of the intestinal mucous membrane. Multiplication occurs asexually through nuclear division followed by fission, through direct or indirect sporulation with or without the formation of a resistant membrane, the resulting spores being amœboid, flagellated, or crescentic, etc. In some Protozoa the whole cycle of development occurs in one host, in others two hosts are necessary, the sexual development only taking place in one of these (malarial parasites of birds and man). In the case of the malarial parasites we have the formation, alongside of the asexually produced individuals, of dissimilar male and female parasites in the blood which undergo a true sexual process in certain species of Culicidæ (see article on "Malaria"). In other Protozoa we have a simpler sexual process through conjugation of similar individuals, the resulting organism becoming encysted or not. In Infusoria partial conjugation occurs, the micro-nuclei being interchanged, after which the organisms again separate. The reader is referred to the works mentioned in the bibliography for further details regarding Protozoa.

HYPHOMYCETES

The Hyphomycetes, or moulds, are plants composed of cells of minute size, the cells which do not contain chlorophyll possessing a membrane and colourless protoplasm. The membrane is composed of a substance allied to cellulose, whilst the protoplasm usually contains numerous minute nuclei, oil-drops, pigment, vacuoles, crystals of oxalate of potash, but no starch. Through the growth of the distal extremity of the cell, threads (hyphæ or mycelia), usually composed of transversely segmented cells, are formed. In Mucor the whole mycelial mass is composed of a tangled and branched unsegmented tube until the occurrence of fructification. Branching may be dichotomous or irregular. Adjacent threads of a mycelium may become fused. In the laboratory mycelial masses are often observed growing in the deeper layers of media. The mycelial threads have the power of penetrating into dead or living animal and vegetable tissues, boring their way into or between the cells, frequently the cell itself being penetrated by delicate processes of mycelium known as haustoria. Under certain conditions the mycelium forms sclerotia or resting bodies, which on cross-section are seen to be composed of a cortical layer composed of terminal cells covered with a dark coloured membrane, and containing a central mass composed of densely tangled hyphæ. Multiplication occurs either sexually or asexually. The asexual process consists in the formation of endospores within a sporangium (Mucor) or conidia formed by direct cleavage of the extremity of the fruit-bearing thread which arises from the mycelium (Penicillium). Endospores are formed directly out of the plasma of the sporangial cell. Where the sporangia are club-shaped they are termed asci, and the spores ascospores. Through agglomerations of asci certain forms give rise to bottle-shaped bodies termed perithecia, or beaker-shaped bodies termed apothecia, which contain the asci. The spores are liberated or ejaculated through deliquescence or rupture of the sporangial wall. Conidia may be round, oval, spindle-shaped, or rod-like, and are usually developed terminally or laterally from conidia-bearers, rarely directly from hyphæ. They are often supported on delicate stems termed sterigmæ. Single or numerous processes bearing conidia may be formed, or a series of conidia may be given off in succession from the same process. When the number of conidia-bearers and conidia is uniform we speak of a basidium (Basidiomycetes). The conidia drop off through withering of the sterigmæ, through fission, or they are thrown off forcibly through bursting of the conidia-bearer beneath the conidia, the expelled fluid propelling the conidia to a distance. In the Phycomycetes naked cells bearing two cilia, and consequently motile (swarm-spores), are formed in the sporangia, which swell up and liberate their contents into the water. These spores swim about, and after a time they settle down, develop a membrane, and sprout. In some Asco- and Basidiomycetes pleomorphism exists with regard to spore-formation. Some forms develop only upon a single host, others require two hosts. Certain moulds at times form peculiar bodies termed pyknidæ, consisting of a hollow structure containing numerous conidia-bearers, whose conidia either sprout and form a mycelium, or serve directly as mother-cells for fresh spores.

Sexual development occurs either directly through copulation of two swollen mycelial extremities coming in contact and fusing, whereby they give rise to a zygospore, or through the formation of a male element (antheridium), which grows out of the hypha, and, coming in contact with the female element (oogonium) which appears as a swelling of the mycelium, sends a process into it, whereby it becomes fertilised, giving rise to an oospore which becomes surrounded with a membrane of cellulose. Prior to sending this process into the oogonium the antheridium becomes separated from its hypha by a cellular partition.

Blastomycetes (Yeasts)

The yeasts occur as minute, round, or oval cells, which are larger than the bacteria, and multiply by budding, the buds springing from any part of the mother-cell, growing in size, and in turn giving rise to buds. Yeasts do not possess chlorophyll. The cells may become separated or remain adherent to one another, and they may be differentiated into an outer double contoured membrane containing plasma including vacuoles, droplets of fat, and granules. Nuclei have been demonstrated in some species. Certain yeasts form chains in old cultures, and when exposed to the air, the cells being elongated and remaining coherent (Mycoderma cerevisiæ and M. vini). It is claimed by some that some yeasts form a true mycelium (Torula), whilst in certain cases a yeast-like growth has been observed to occur in moulds. For this reason Brefeld has included the yeasts under the Hyphomycetes, but Hansen objects to this on the ground that nearly all the yeasts possessing industrial importance produce spores and rarely mycelia, for which reason he gives this group the generic name of Saccharomyces. According to Cao (1900), it appears certain that many of the organisms claimed to have been Blastomycetes truly belong to the genus Oidium. Oidium albicans (formerly called Monilia candida, and often taken for Saccharomycetes), the cause of "thrush," is a case in point. The members of this genus hold an intermediary position between the

Hyphomycetes and Blastomycetes, in that they form a true mycelium like the former and multiply like the latter. Cao denies that true yeasts form a mycelium. Besides budding certain yeasts multiply through spore formation. As Hansen has shown, sporulation may often be observed in yeasts which are planted upon a surface of plaster of Paris and kept under conditions of moisture. The spores, two to four in number or more, appear in each cell as spherical bodies slightly flattened upon their juxtaposed surfaces. The spores stain by the same methods used for staining bacterial spores, being more resistant to staining reagents than are the vegetative cells.

Though a number of yeasts have been found of late to exert a pathogenic action, their chief interest lies in their power to produce certain fermentations possessing industrial importance (beer, wine, etc.). It is chiefly due to Hansen that their action has been studied in pure culture, and the most suitable forms isolated and used in practice to the exclusion as far as possible of "wild" yeasts which frequently injure the product. Pure cultures of yeasts may be obtained by the methods ordinarily employed in the cultivation of bacteria, suitable media being used. Yeasts may be differentiated by the nature of the fermentation they produce, their appearances in culture and microscopically, and the influence of temperature upon their sporulation and sprouting, as also when pathogenic by their effects upon animals. (See also "Post-Mortem Examination.")

STREPTOTHRICES

The Streptothrices hold an intermediary position between the bacteria and moulds, in that they are formed of intertwined threads which are branched, frequently not segmented, and at times terminating in spore-like bodies. The threads (comparable to the mycelium) may break up into segments resembling bacilli. In this class belong the Streptothrix (Actinomyces) bovis, S. maduræ, and a number of other forms which have of recent years been found to exert a pathogenic action. Since branching forms of the Bacillus tuberculosis, B. lepræ, B. diphtheriæ, B. mallei, and other micro-organisms usually classed under bacteria have been observed, the latter strictly speaking should be classified as Streptothrices. All of these forms at times also show clubbed extremities similar to those observed in organisms belonging to this group. For convenience sake the micro-organisms named are for the present retained under bacteria.

BACTERIA

The Schizomycetes, or Bacteria, include by far the greatest number of known micro-organisms. They constitute the simplest and lowest forms of vegetable life and are of very minute size. Their dimensions are stated in microns, a micron, usually expressed by the Greek letter μ, being equivalent to 0·001 mm. Bacteria vary in size from 0·3-3·0 μ. They may be spherical (Micrococcus), cylindrical (Bacillus), spiral (Spirillum and Spirochæte) the generic names being based upon these fundamental forms. Multiplication occurs through growth followed by division. Under suitable conditions, this growth and multiplication may be directly observed. In bacilli the growth occurs in the direction of the long axis only, the segmentation occurring transversely, in Micrococcus tetragenus it occurs in two directions, giving rise to groups of four organisms, whereas in the Sarcinæ division occurs in three dimensions, the coherent cells forming cubical bales of eight or more cocci. The multiplication may be very rapid, in the case of B. subtilis it has been observed to occur in twenty minutes. In the act of dividing cocci may appear like short bacilli, and bacilli which are multiplying rapidly may simulate a coccus, but no confusion need result if the examination is made carefully under different conditions of growth. Though the typical micrococcus is spherical, certain forms when remaining in juxtaposition become modified in shape. This is the case with the M. gonorrhœæ, where the opposing surfaces are flattened and somewhat indented, the cocci being also somewhat broader along the axis which runs parallel to the line of fission. The pneumococcus, on the other hand, when occurring as a diplococcus, is lanceolate at the free extremity, whence the name M. lanceolatus often given to it. Flattening of apposed surfaces is seen in M. tetragenus and in the Sarcinæ. Bacilli in chain-forming, non-motile forms like B. anthracis, are flattened at the extremities, whereas most of the motile forms are rounded. The body of the bacillus may be straight or slightly curved, (B. megatherium). Both bacilli and spirilla vary considerably in the proportion between length and width. We speak of a short bacillus when the length is about twice that of the width, of a long bacillus when the length is four to ten times the width. Whereas the smallest bacillus known, that of influenza, measures 0·2-0·4 μ, the anthrax bacillus measures 3 by 1 μ. Considerably larger forms are, however, known. The typical form of bacilli may be considerably modified during spore formation; it may be simply widened, as in B. anthracis and B. megatherium, bulged out at either side so as to form a "clostridium" (B. butyricus), or be very much expanded at one extremity so as to include a spore which is wider than the cell which has formed it (B. tetani), giving rise to the "drum-stick" appearance. Under certain conditions, which are usually adverse to their growth, cocci, bacilli, and spirilla (streptococci, B. anthracis, cholera spirilla) may become remarkably modified in form (involution and fragmentation forms), so that they no longer resemble the parent form. These involution forms, which take the most variable shape and react feebly to stains, may often be resuscitated if brought under favourable conditions, giving rise again to normal-looking micro-organisms. Fragmented forms have been mistaken for spores. That many of the involution forms are really due to degeneration is evident from their reaction to stains. Under certain slightly unfavourable conditions segmentation may be retarded in bacilli and spirilla, long threads being formed which on staining are seen to be continuous. In certain forms (Cladothrix and Proteus) pseudo-branching occurs through a break in the chain, the chains continuing to grow away from each other, but remaining adherent by means of the membrane. This must not be mistaken for the true branching of Streptothrix, where on staining the protoplasm is seen to be continuous. In Thiothrix the organism may be differentiated into short, broad, basal, and narrow, long, apical cells, the former being attached to the substratum. The spirals formed by Spirilla vary, the chains either presenting an undulating appearance, or being so closely twisted as to resemble a corkscrew, the organisms almost touching each other laterally. Single cells viewed from one side have been compared to a comma (not the printed, but the written comma), whilst two which have remained united may resemble an S or written E. Though the Spirochæte are usually included under Spirilla they are essentially different. Whereas Spirilla may be regarded as spirally wound chains of bacilli, each cell forming part of the spiral, the organisms being provided with flagella and having rounded ends, the Spirochæte are to be regarded as single thread-like, spirally wound cells which taper at their extremities, are not possessed of flagella and move by protoplasmic contractions which are very evident in the occasional bending of the spiral at one or more points along its length.

All motile bacteria, with the exception of the forms just mentioned, are provided with locomotory organs or *flagella.* Though it is claimed that flagella have been seen in unstained organisms of large size, their presence is only indicated in smaller organisms by the commotion they produce in the surrounding medium. It is necessary to resort to staining for their demonstration. The number of flagella, as well as their distribution upon the surface of the bacterium, varies according to the species. There may be a single flagellum at one end, one at each end, bunches of flagella at the ends, or flagella may be given off in all directions from the surface of the organism. In the spirilla these organs are more rigid than in bacilli and micrococci, where they are wavy. The flagella are delicate processes of fairly uniform width, and often considerably exceed the length of the organism which carries them. Curious bodies, which have been termed "giant-whips," have been observed in cultures of most motile bacteria, these being apparently made up of conglomerations of cast-off flagella. Their full significance and mode of growth are unknown. It is reasonable to suppose that the flagella constitute direct processes of cell protoplasm, which in a condensed form gives rise to the cell membrane from which the flagella issue. Trenkmann has demonstrated in a large species of spirillum that the flagella traverse the capsule which surrounds the organism. It is quite possible that the flagella are retractile, and it has been suggested that they may fulfil the function of absorbent organs. They are best demonstrated in young, actively-growing cultures, being largely absent in organisms in old cultures.

Most bacteria develop *capsules,* these being very thick in certain species, their presence being indicated in unstained bacteria by an invisible something which keeps them more or less equidistant from one another. Capsules may be demonstrated by suitable stains. In certain species very large coalescent capsules are formed, which give rise to so-called zoogl\oeal masses. Depending upon the density of the capsule the zoogl\oea may be more or less firm. Whereas capsules are usually of uniform thickness they may show a curiously unilateral development (B. pediculatus), or lead to the formation of ramified colonies. It is the capsule which causes the organisms to hang together in chains, groups, and pellicles, etc. The capsules at times show a greater resistance than the bacterial cell which has produced them. This may not infrequently be seen in pneumonic sputum, which may be largely made up of empty capsules, the presence of which gives a peculiar consistence to the sputum.

Whereas some bacteria seem to evolve certain individual cells (so-called *arthrospores*), which are characterised by a higher degree of resistance than that possessed by ordinary vegetative cells, and thus secure their continued existence under adverse conditions, others form more or less highly resistant spores. Though true *endogenous spore-formation* has been observed in micrococci and spirilla, in the vast majority of cases they are only observed in bacilli. Spores are formed within the mother-cell, being either smaller or larger than the cell. Spores vary in shape in different species, being either round or oval. When an organism develops spores it loses its previously homogeneous appearance; refractile bodies are formed, which grow in size or coalesce until they attain the dimensions of fully-grown spores. The remains of the cell and cell-membrane finally disappear, and the spore is liberated. Both Klein and Kanthack have seen bacilli retain their motility whilst forming spores, but as a rule bacilli cease to be motile during spore-formation, and die and degenerate after spores are developed, owing to the fact that practically all the protoplasm has become concentrated in the spore. Spores are usually formed under conditions which are adverse to the further development of the organism, and represent the resting stage in its development. When spores are placed in a suitable medium they germinate, *i.e.* they gradually lose their characteristic, highly refractive appearance, swell up, and give rise to new vegetative forms, which in turn form spores. The mode in which the organism issues from the spore membrane constitutes a specific character: some issue at right angles to the length of the spore, others in the direction of the longitudinal axis. When the bacillus appears certain forms exhibit a definite spore-membrane, which shows evidence of considerable elasticity, whilst in others such a membrane is not visible. An exceptional mode of sprouting has been observed by Sorokin in a Spirillum, where vegetative cells have been seen to develop from spores whilst these are still retained within the mother-cell. It is the rule, however, that spores only sprout after they have been liberated. Some spores possess a considerable degree of resistance to heat and chemical agents. Whereas the vegetative cells of anthrax are almost immediately destroyed in boiling water, the spores may resist boiling for four to twelve minutes. Certain spores frequently found in soil have been known to resist boiling for six to eight hours. The greater resistance of spores to heat has been attributed to their protoplasm being more concentrated, for the reason that the greater the amount of water in protoplasm the more readily will it become coagulated. Nevertheless the resistance of spores may be attributable to some difference in molecular structure. Whereas the specific gravity of vegetative cells is 1038-1065 (Rubner) that of spores is somewhat higher (Almquist).

Viewed unstained bacteria appear as undifferentiated, almost colourless bodies. That they possess a membrane is shown by plasmolysis and the phenomena attending sporulation and degeneration. The membrane is different from that in higher plants in that it does not give the cellulose reaction. Some investigators have claimed that the whole bacterium constitutes a nucleus, whilst others look upon certain bodies (Ernst-Neisser bodies) as being equivalent to nuclei. The fact that usually the whole bacillus reacts to nuclear stains has formed the basis for the first statement, the fact that with certain stains small intensely staining bodies appear has been brought forward in support of the other view. In neither case is the evidence entirely satisfactory. In Beggiatoa we find granules of sulphur deposited in the cell. In other forms iron is deposited within the capsule. At times the protoplasm seems broken up by vacuoles, so that when stained the organism (B. lepræ, B. tuberculosis, B. diphtheriæ, etc.) appears transversely banded or "beaded." Bacteria generally resist the action of dilute alkalies. On the addition of iodine they stain yellow; a few give a starch-like reaction.

The use of bacteria in nature is incalculable. The dead bodies of animals and plants which would otherwise accumulate are made to disappear and enrich the soil. The effects of their vital processes are daily seen in the formation of manure, the manufacture of bread, wine, etc.

Bacteria are very widely distributed, being present in the air except in mid-ocean, the expired air, and the air at high altitudes. They have been found in water, ice, snow, and hail. They are absent in the water of deep Artesian wells, but present in all surface waters and the water of shallow wells, as also in the surface layers of the soil. They are usually absent from the tissues of normal animals and plants, though they are numerous in the alimentary canal of all animals, excepting in the Arctic regions, where they may be absent. In the Leguminosæ they are present in the root-nodules apparently under conditions of symbiosis.

The composition of bacteria varies within wider limits than that of any other known organisms, it being to a considerable extent dependent upon the chemical composition of the medium within which they grow. In other words, they possess great powers of adaptation. The bacterial cell is composed of about 89 per cent water, and 11 per cent dry substance (Hammerschlag). The solid constituents of the protoplasm are chiefly protein in character. Fats are always present. In B. tuberculosis about 37 per cent fat may be present (de Schweinitz), whilst according to Dyrmont spores contain more fat and nitrogen than vegetative cells. At times a carbohydrate like granulose would appear to be present. The inorganic constituents represented by the ash amount to about 10 per cent of the dried substance. The proportions between the constituents of the ash varies in different species, as also in the same species under different conditions. A striking feature of B. tuberculosis is the large amount of phosphoric acid contained in its ash, the same amounting to as much as 55·23 per cent, whereas in the cholera germ we find but 20·48 per cent.

According to whether bacteria live upon dead or living matter, as well as according to their most characteristic effects, they have arbitrarily, and for the sake of convenience, been classified into zymogenic (fermentative), chromogenic (pigment producing), aerogenic (gas producing), saprogenic (putrefactive), photogenic (light producing), toxicogenic (poison producing), and pathogenic (disease producing) organisms. Thermophyllic bacteria are such as grow at particularly high temperatures, *i.e.* at times at a temperature of 60° to 70° C. According to whether the organism grows in the presence or absence of atmospheric oxygen they are distinguished as aerobes and anaerobes. Certain forms are "facultative," that is, they are capable of multiplying under either the one or the other condition. In the case of true anaerobic organisms the vegetative cells are actually killed through exposure to the air. There is but a single anaerobic micrococcus known; all other known anaerobic bacteria are bacilli. Investigations just published by Klett (1900) show that we must define in future what is meant by anaerobiosis. It has always been claimed hitherto that B. anthracis requires oxygen for spore-formation, and that this probably explained the absence of spore-formation in the animal body. The contrary is the case with the bacilli of tetanus and malignant œdema, which forms spores in the body. Klett has found that B. anthracis forms spores in a nitrogen, but not in a hydrogen atmosphere, which indicates that the latter gas is not "neutral" as has been hitherto claimed.

Nutrition and Assimilation.—The nutrition of bacteria occurs through the diffusion of soluble substances from the surrounding medium into the bacterial cell. With the exception of a few green forms bacteria do not assimilate carbon from carbon dioxide. In fact the majority give off CO_2 like animals. They obtain their carbon from organic compounds, as also from simple compounds like glycerin, tartaric and lactic acids. Their nitrogen is derived from protein compounds, but also from simpler compounds like asparagin and the amido acids, though a number can obtain their nitrogen from inorganic compounds like ammonium, chlorides, and nitrates. In the nodules of the Leguminosæ the bacteroids take up the nitrogen of the atmosphere, thus aiding the plant in which they live, and enriching the soil. Hydrogen is derived from organic compounds, ammonia, or water. Aerobic forms derive their oxygen from the air, anaerobic forms from proteins and carbohydrates. Some species, like Engelmann's B.

chlorinum, give off oxygen. Sulphur and phosphorus are derived from organic or inorganic (sulphates and phosphates) matter. The so-called sulphur bacteria oxidise H_2S to S, the oxidation of sulphur giving the cell the energy due to oxidation of albumin in higher organisms. Chlorine is derived from chlorides, whilst sodium, potassium, calcium, and iron, the latter usually present in traces, are readily procurable both in organic and inorganic matter. Most bacteria prefer a neutral or slightly alkaline medium; acidity equal to 20 to 30 c.cm. normal acid solution per litre (as tested by litmus) inhibits their growth. Bacteria form a contrast to moulds in this respect. Bacteria cause changes in the surrounding medium through the agency of ferments, acids, etc., which they give off. By crushing yeast-cells and filtering their contents through a stone filter Buchner showed that the cells contained a ferment capable of converting cane-sugar into CO_2 and alcohol. Macfadyen, Morris, and Roland (1900) in repeating Buchner's experiments, find that the substance of the crushed yeast of itself gives off large quantities of CO_2 and alcohol, which indicates that the fermentation changes take place within the cell protoplasm. Similarly it has been found that bacteria elaborate certain substances within their protoplasm which are capable of producing chemical changes in a medium. Whilst some organisms do not allow their products to diffuse to any considerable distance into the medium others do so. We can observe this macroscopically in pigment-producing bacteria, some of which give off a highly soluble pigment which diffuses quickly throughout the medium (B. pyocyaneus), others a pigment which is deposited in the vicinity of the cells (B. prodigiosus). So it is with peptonising ferments. Some liquefy at a considerable distance (liquefying bacteria), others do not apparently liquefy, but none the less their bodies have been found to contain the ferment (B. typhi, B. tuberculosis). Similarly some forms give off highly diffusible toxins, others not. We have already referred to anaerobic organisms. In nature these organisms find conditions for their multiplication through the presence of aerobic forms which rob the medium of its free oxygen, and possibly exert an influence through their products. Aerobic forms, when motile and growing in media in which the oxygen is lessened, seek the surface or the bubbles of air it may contain. A very beautiful experiment of Engelmann's made upon a thread of Spirogyra beneath the microspectroscope has shown that such bacteria will accumulate along those portions of the Spirogyra which lie across the rays of light in which oxygen is most liberated. This motion in the direction of oxygen or desired food-substance is known as positive chemotaxis. Substances which do not attract or repel micro-organisms are spoken of as negatively chemotactic. The motion of bacteria varies in rate and kind according to the particular species. Motile anaerobic forms cease to move when exposed to the air, the reverse being the case with aerobic organisms. The motion is influenced by temperature, still more so the rate of multiplication, and consequently the physiological activity. Between the lowest and highest temperature at which an organism will grow (minimum and maximum temperatures) there is a temperature at which it grows best (optimum temperature). The optimum temperature for the growth of most pathogenic forms corresponds to the temperature of the animal in which it is capable of inducing disease. Whereas sporulation occurs best at about the optimum, sprouting occurs usually best at a somewhat higher temperature.

The duration of life in bacteria varies according to the species. The spores of anthrax have been found to live for 22 years in sealed tubes (Pasteur), and the Bacillus tuberculosis has been found alive and virulent after being kept in dried sputum for 95 days. Some pathogenic forms resist desiccation for a considerable time (B. diphtheriæ, pyogenic bacteria, etc.), whilst others are destroyed when dried for only a few hours (cholera spirilla). In mixed cultures, as also in the body, only those organisms survive which are best suited to the conditions. Certain bacteria and their products are antagonistic to each other. B. typhi is rapidly killed off when cultivated with B. prodigiosus, B. coli, etc., whilst the products of B. pyocyaneus are antagonistic to the cholera spirillum. On the other hand B. typhi grows well together with Streptococcus pyogenes. As the result of continued cultivation in artificial media, the action of heat, chemical agents, etc., pathogenic organisms may become attenuated, *i.e.* become lowered in virulence or lose their power to produce pigment, fermentation, and phosphorescence. Attenuated organisms are lowered in their vital powers. Some organisms lose their virulence more rapidly than others when cultivated artificially. The Streptococcus pyogenes, B. pestis, and B. mallei, lose their virulence in a short time in artificial media. On the other hand B. tuberculosis and B. anthracis may retain their virulence for many generations in culture. The application of cold checks the growth of micro-organisms, whilst alternate freezing and thawing are fatal if repeated. A number of bacteria resist continued freezing for a considerable period of time. Prudden found B. typhi still alive after a sojourn of 103 days in ice, though the total number of organisms introduced had decreased. Ravenel found that anthrax bacilli, B. diphtheriæ, B. typhi resisted the temperature of liquid air (– 312° Fahr.) for three hours. The application of cold to food preservation depends upon its power to check bacterial growth. High pressures exert no appreciable effect on bacteria. Light depending upon its intensity retards development, attenuates, or kills bacteria. The spores of anthrax are killed by an insolation of 48 hours, the vegetative cells being destroyed inside of two hours. Electric light has a similar though naturally less intense effect. The growth of bacteria is not affected by the red rays of the spectrum, whilst it is affected by all the other rays, especially the violet. The Bacillus photometricum possesses a peculiar interest in that it is quiescent in the dark and moves toward a source of light. Otherwise all organisms grow best in the dark. It has long been observed that the virus of anthrax persists longest in infected places shaded by undergrowth. The effects of electricity are indirect, really being due to electrolysis, the sodium chloride in the solution being broken up and chlorine evolved, besides which hydrogen peroxide and ozone may be produced. This electrolytic action has been practically applied to the purification of polluted waters. Bacteria are susceptible to the effects of physiological poisons such as ether, chloroform, prussic acid, carbolic acid, etc.

Whereas the majority of bacteria lead a saprophytic existence, *i.e.* live upon dead matter, a certain number may exist as parasites. Certain forms can only lead a saprophytic existence, some may also be capable of existence as parasites, others appear to be obligatory parasites. Some saprophytic bacteria may indirectly produce pathogenic effects through their products, toxins and ptomains (meat-poisoning, etc.), such organisms being described as toxicogenic (B. botulinus).

Saprophytic bacteria may produce fermentation, putrefaction, oxidation, or reduction, nitrification or denitrification of the medium in which they are vegetating. These chemical changes are brought about through the normal physiological functions of the micro-organisms. A large number gives off diastatic or amylolitic ferments, by which they are capable of converting starch into sugars, as do animals by means of their salivary and pancreatic secretions.

Some give off proteolytic enzymes, by means of which they convert albuminous substances into albumose, and albumose to pepton. Many give off this enzyme freely into the surrounding medium, and proteolytic changes are produced at a distance from the cell. We see this in the so-called liquefying bacteria, such as liquefy gelatine and coagulated blood-serum. Similarly with other products. B. pyocyaneus gives off a highly diffusible pigment, B. diphtheriæ and B. tetani, a highly diffusible toxin, whilst in other cases either the proteolytic ferment is not given off freely, though it is contained in and has been isolated from the cell (B. tuberculosis, B. typhi), or the toxin or pigment (B. violaceus, B. prodigiosus, etc.) is not diffusible. Proteolytic enzymes which dissolve fibrin have been isolated from the spirillum of cholera, S. Finkler-Prior, B. prodigiosus, etc. This ferment is destroyed by exposure to a temperature of 55°-70° C. Neither peptonising nor diastatic ferments are produced in the absence of albumin. In insectivorous plants peptonisation is brought about indirectly through the agency of micro-organisms, and the plant thrives upon the products. Some bacteria give off inverting ferments which (as in animals) convert cane-sugar into glucose. Others give off rennet-like ferments, which curdle milk, others fat-splitting ferments, which cause the rancidity of butter or fat.

There is no essential difference between fermentation and putrefaction, the difference being but one of degree. Broadly speaking, a fermentation process (the term being used in the ordinary sense) results in few products, whilst in putrefaction they may be numerous, the process being accompanied by the evolution of evil-smelling gases. Putrefaction occurs in complex dead vegetable and animal matter: the protein, which contains carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus, being split up into ammonia, amines, indol, and skatol, containing the nitrogen and hydrogen sulphide, mercaptan, etc., containing the sulphur derived from the protein molecule. In putrefaction the medium often becomes alkaline (ammonia, etc.). The term fermentation is vulgarly applied to changes taking place in carbohydrate solutions. Owing to the formation of organic acids a fermenting solution gives an acid reaction. A fermenting fluid often gives off an agreeable odour.

The chief fermentations are the alcoholic, acetic, lactic, butyric, viscous, fatty, and ammoniacal fermentations. Other fermentations are those which result in nitrification and denitrification. These processes are accompanied by oxidation and reduction, the commonest change being that of hydration. Alcoholic fermentation is chiefly produced by yeasts; it may also be produced by moulds (mucor) or bacteria (intestinal bacteria, B. typhi, B. pneumoniæ). After a certain amount of alcohol has been formed in the process of fermentation (the amount reached in beer fermentation is 5 per cent, in that of wine 10-15 per cent) the fermentation process ceases, the alcohol checking the further growth of the yeast. In alcoholic fermentation we have the following changes taking place:—

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6$$
$$C_6H_{12}O_6 = 2C_2H_6O + 2CO_2.$$

The chief product is alcohol, the secondary products being CO_2, aldehyde, higher alcohols (butyl, propyl, amyl alcohol), glycerine, acetic, succinic acid. E. Buchner has succeeded in proving that yeast cells contain a ferment capable when isolated of producing alcoholic fermentation. In the various industries considerable importance is attached to the utilisation of definite species of yeasts, which yield the highest percentage of alcohol or the most desirable product. In bread-making yeast and bacteria are added to the dough; the bacteria convert the starch into sugar, and the yeast converts the sugar into alcohol and CO_2, the gas distending the bread. In acetic acid fermentation we have alcohol oxidised to acetic acid according to the formula—

$$C_2H_6O + O_2 = C_2H_4O_2 + H_2O.$$

For this process free access of air is needed, the amount of alcohol present must be under 15 per cent, the best temperature being 30°-35° C. After about 14 per cent acetic acid has been produced fermentation is checked by this product. A considerable number of bacteria are known which produce acetic acid (B. aceti), etc., pneumococcus, B. lactis aerogenes, B. coli, etc.). In lactic acid fermentation glucose ($C_6H_{12}O_6$) is converted into lactic acid ($C_3H_6O_3$) and other secondary products, such as alcohol, acetone, formic and acetic acids. Butyric acid fermentation is usually produced by anaerobic organisms, the glucose being converted into butyric acid ($C_4H_8O_2$), carbon dioxide, and hydrogen. Viscous or slimy fermentation occurs at times in milk, urine, beer, wine, and sugary solutions, a carbohydrate, dextran ($C_6H_{10}O_5$), allied to dextrin, being formed, the medium becoming gelatinised. The capsules formed about Leuconostoc mesenteroides, when grown in sugary solutions, are almost entirely composed of this substance, no capsules being evident when this organism is grown in sugar-free media. The fermentation occurring in fats results in their becoming rancid. In ammoniacal fermentation a process of hydration occurs, urea being broken up as follows:—

$$CO(NH_2)_2 + H_2O = CO_2 + 2NH_3.$$

The products uniting to form ammonium carbonate.

A fermentation process of great importance in nature is that which results in nitrification, whereby the useless nitrogen derived from living beings is converted into the useful nitrates which are utilised by the plants in the soil. Nitrates are always the end products of the decomposition of animal matter in the presence of bases. Nitrates are formed in manure. They are the important constituents of guano and of commercial soda-saltpetre. The ammonia formed is oxidised to nitrous and nitric acids, and these combine with bases. In examining water suspected of being polluted with organic matter, one tests for nitrates and nitrites. The nitrifying bacteria are separated into two groups: the nitroso-bacteria, which form nitrous acid, giving rise to nitrites, and the nitro-bacteria, which oxidise nitrous to nitric acid, giving rise to nitrates. Certain bacteria denitrify, *i.e.* they exert an opposite effect.

The products of bacteria depend for their amount upon the favourable or unfavourable conditions of medium, temperature, and vital activity of the particular micro-organism. The presence of antagonistic or other forms of bacteria will modify the growth and products of a given micro-organism. Some bacteria produce acid, others alkali—these physiological differences being of use in the determination of the species. We have already seen how different the products are for different species, and considerable differences may be observed in the growth and products of one and the same micro-organism in media of different constitution. As far as the experimental evidence goes, the accumulation of products checks the growth prior to the exhaustion of the medium, the growth ceasing owing to the amount of acid (0·8 per cent in lactic acid, 10 per cent in acetic acid fermentation) or alcohol (maximum 15 per cent), phenol, and other products present in the nutrient solution.

A considerable number of bacteria produce *ptomains*. Ptomains are crystallisable nitrogen—containing bases which are very similar to vegetable alkaloids. Besides nitrogen they contain carbon, hydrogen, and sometimes oxygen. Some ptomains are toxic, others not. Ptomains were first isolated by Nencki in 1876 from various organic substances undergoing putrefaction, as also from pure cultures of pathogenic bacteria. Toxic ptomains were separated from cultures of B. typhi, Spirillum choleræ asiaticæ, B. crassus sputigenus, etc., by Brieger. Nencki and Marmé were unable to isolate a ptomain from cultures of B. anthracis. Until the discovery of the vastly more potent toxalbumins of certain pathogenic bacteria more importance was attached to the ptomains. It is possible that ptomains exert some effect in cholera and typhoid fever. Bacteria which produce poisonous ptomains are called toxicogenic, but are not necessarily of themselves pathogenic. Ptomains play an important part in ice-cream, cheese, meat, sausage, fish, and canned food poisoning. Food containing large quantities of toxic ptomains has often been eaten without suspicion.

From the point of view of pathogenesis the greatest importance is to be attached to the specific bacterial *toxins* which are formed within the bacterial cell. These are unstable compounds which are injured by heat, light, and various chemical agents. Their chemical composition is highly complex, and remains to be determined. It has been proved that they are not ptomains, basic substances, nor proteins. The toxins are specific products of the physiological activity of certain bacteria. In cultures of B. diphtheriæ and B. tetani they are highly diffusible. The toxicity is very great in both of these; 0·002 c.cm. of a filtered diphtheria culture, or even less, may be fatal to a guinea-pig, whilst 0·000,000,05 gram. of purified tetanus toxin kills a mouse of 15 gram. weight, the estimated fatal dose for a man of average weight being $\frac{1}{280}$ of a grain. Toxins have been isolated from B. diphtheriæ, B. typhi abdominalis, B. tetani, Spirillum choleræ asiaticæ, pneumococcus, B. tuberculosis, B. mallei, and B. pestis, but not from B. anthracis.

Certain bacteria produce a characteristic pigment, such forms being termed chromogenic. The pigment may be red, violet, yellow, green, etc., and its character often serves for the differentiation of species. A number of bacteria are photogenic, *i.e.* phosphorescent, and may cause fish, meat, or sausage to become luminous. The greater number of phosphorescent bacteria occur in sea-water.

A considerable amount of *heat* may at times be produced as the result of bacterial activity. When complex bodies are broken up during the fermentation process induced by bacteria, yeasts, or moulds, heat is liberated. Fermentation occurring in damp hay, grain, and cotton may lead to spontaneous combustion. The rise of temperature in manure-heaps is familiar to all. In alcoholic fermentation due to yeast, as also in the fermentation of hops, tobacco, potatoes, and turnips which have been stacked in a damp state, a rise of temperature of 50°-60° has been observed. A temperature of 70° C. may be reached in the fermentation of sauerkraut.

* * *

Confining ourselves to those micro-organisms which produce disease in the animal and vegetable kingdom, it may be stated that all of the above described groups comprise organisms which exert a direct pathogenic action. Limiting ourselves to man, we find *Protozoa* causing tertian, quartan, and æstivo-autumnal malaria, and also amœbic dysentery. *Moulds* cause herpes, thrush, and favus, and fatal pneumonia has been caused by Aspergillus. A number of yeast-like organisms are pathogenic. Colpe (1894) isolated a pathogenic form from a case of chronic cervical endometritis, Busse (1895) isolated another form from a case which he describes by the name of "Saccharomycosis hominis," the disease having the form of chronic pyæmia, and the germ isolated in culture producing fatal disease in white mice. Sanfelice has found a species, S. neoformans, which is pathogenic for dogs, mice, and the chicken, another species (S. litogenes) which is pathogenic for cattle, guinea-pigs, and white mice. Gilchrist and Stokes describe a species (Blastomycetes dermatitidis, 1898) which was the cause of a dermatitis in man, the cultivated organism proving pathogenic for the horse, dog, sheep, and guinea-pig. Out of fifty Blastomycetes examined for their pathogenicity by Rabinowitsch (1896, some of these, no doubt, belong to the genus Oidium), seven species proved to be pathogenic to experimental animals.

The so-called "cancer bodies," or cell-inclusions observed in cancer have been claimed by some investigators to represent Blastomycetes (Sanfelice, Plimmer), whilst others have claimed them to be Protozoa. Neither Sanfelice nor Plimmer have established the histological identity between their experimental tumours (produced by inoculation with Blastomycetes), and sarcoma or cancer. The only two observations by Sanfelice in which dogs acquired cancer-like tumours, gave negative cultural results, and showed cell-inclusions the morphology of which was very different to that of the organisms introduced. The choice of dogs for these experiments does not seem to be entirely fortunate, when we remember the facts stated by Fröhner regarding the frequency of cancer in dogs studied by him in Berlin, where 40 per cent of the dogs coming to operation proved to be cancerous. It remains still to be proved that Blastomycetes can produce epithelial proliferation, in other words, that they stand in any etiological relationship with cancerous processes. Pianese, Dean, and many others consider the cancer-bodies to be due to degenerative changes. There are things which speak for and against the parasitic theory of cancer, it remains still to be proved that it is due to a parasitic micro-organism. Out of a total number of forty-one species of Oidium, isolated and studied by Cao, twenty-eight proved to be pathogenic for animals.

Streptothrices are pathogenic agents in actinomycosis and Madura-foot disease, whilst specific *bacteria* have been proved to be the cause of anthrax, tuberculosis, diphtheria, pneumonia, glanders, gonorrhœa, typhoid, tetanus, cholera, influenza, plague, Malta fever, cerebro-spinal fever, malignant œdema, suppurative processes, erysipelas, rhinoscleroma, soft sore, leprosy, and relapsing fever, etc.

LITERATURE.—**Protozoa**: see the works of Labbé, Wasielewski, Pfeiffer. **Moulds, Yeasts, and Bacteria**: see the works of Flügge, Duclaux, Sternberg, and the numerous smaller text-books, amongst which those of Günther, Abbott, Muir and Ritchie may be recommended. The chief journals are: Baumgarten's *Jahresbericht*, Koch's *Jahresbericht*, *Centralblatt für Bakteriologie* (Abtheilung i. and ii.), *Zeitschrift für Hygiene*, *Annales de l'Institut Pasteur*, *Journal of Experimental Medicine*, *Journal of Pathology and Bacteriology*, *Hygienische Rundschau.*

Microscope, The.

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See also POST-MORTEM.

MICROSCOPES are of two kinds, simple and compound. *The compound microscope* consists essentially of two lenses—one, the object glass, forms an enlarged, inverted, and reversed image of the object; whilst the second lens, termed the eye-piece, magnifies this image and is placed between it and the eye of the observer. In all modern microscopes the object glass is replaced by a combination of lens known as the objective, and the eye glass is represented by a combination of lenses termed the ocular. The objective and ocular are mounted at the ends of a tube which can be made to recede from or approach a square or rounded stage which has a central aperture. Beneath the stage is the illuminating apparatus. This consists of a mirror to reflect rays of light upwards through the opening in the stage, and on to an object lying on the latter. One side of this mirror is a concave, and the other a plane mirror. Attached to most microscopes there is also a system of lenses, termed a condensor, placed between the mirror and the stage—the condensor serving to focus on the object the rays of light proceeding from the mirror. The whole instrument is supported on a foot or base which is either of horse-shoe form, as in most Continental models, or in the form of a tripod—a microscope with the latter being the more rigid instrument. The foot should be jointed so that the microscope may be inclined to any angle.

Objectives.—Each consists of a combination of lenses mounted in a tube, the upper end of which can be connected by means of a screw thread to the lower end of the tube of the microscope. Formerly there were several different forms of screw thread, but now all makers have adopted the English thread, or what is termed the Society's screw thread. There are two classes of objectives—dry and immersion, and each have their own uses. In *dry objectives*, the lens nearest the object—the frontal—remains separated by air from the object or the cover-glass over it. In the case of an immersion objective, a drop of liquid is interposed between the frontal and the cover-glass, and the liquid employed should have a refractive index the same as, or approaching as closely as possible to, that of the glass forming the frontal. With a water-immersion objective a drop of distilled water, which has a refractive index of 1·33, is used; with a homogeneous immersion objective, cedar oil with a refractive index of 1·51 is employed, as this is likewise the refractive index of crown-glass. In dry and immersion objectives both chromatic and spherical aberration are largely corrected, and these objectives are therefore termed achromatic. In apochromatic objectives both forms of aberration are still more completely corrected, but as their use is not essential for ordinary work the reader is referred to standard works on microscopy for a detailed description of such objectives. Their value lies largely in the fact that they can be used with oculars of high magnification, and in their suitability for microphotography.

The terms focal distance, frontal distance, resolving and defining power, angle of aperture, and numerical aperture require explanation. The *focal* *distance* is the distance of the focus from the lens, and objectives are distinguished by their focal distance measured in inches or millimetres, although the dry objectives of Continental makers are often designated by the numbers I., II., etc. (Leitz, Reichert, and others), or by the letters A, B, C, etc. (Zeiss). The *frontal distance* is the distance between the frontal of the objective and the cover-glass when the object is accurately focussed. The *resolving power* of an objective is its power of showing detail, whilst the *defining power* is its power of defining outline. *Numerical aperture.*—The resolving and defining powers of an objective depend, apart from its correction for spherical and chromatic aberration, on its angle of aperture which is defined as "the angle formed by the two extreme rays emanating from the object, and utilized by the objective" (van Heurck), and the greater the angle of aperture the greater is its resolving power. But the angle of aperture also depends on the refractive index of the medium interposing between the objective and the object; and each objective has what is known as a "numerical aperture" (N.A.), which is represented by the sine of half the angular aperture multiplied by the refractive index of the medium (air, oil, etc.)—thus N.A. $= n \sin u$, n being the refractive index of the medium, whether air, water, or oil. The refractive index of air is taken as 1; that of distilled water is 1·33; and that of cedar oil 1·51. By the above equation it is found that a homogeneous immersion objective with an angular aperture of 82° has the same numerical aperture as a dry objective with an angular aperture of 180° the numerical aperture of each objective being 1; hence homogeneous immersion objectives having an angular aperture greater than 82° have a larger aperture than dry objectives of 180°, and thus have greater resolving power, or in other words, are of greater value for the observation of very minute structures. Thus a dry objective, the N.A. of which is 0·88, and a homogeneous immersion objective with a N.A. of 1·30, each with a focal distance of $\frac{1}{10}$-inch, give the same amplification, yet the latter having the greater resolving power is consequently to be preferred. Another advantage of an immersion objective over a dry objective of the same magnifying power is that the former has a greater frontal distance, and is therefore more easily used.

The ocular commonly used is known as a Huyghenian ocular, and is composed of a tube, at each end of which is a plano-convex lens with its convex surface towards the objective. These lenses are termed respectively the eye lens and field glass, and between them is a diaphragm.

The tube forming the body of the instrument, and to the lower end of which the objective is attached, is furnished with an inner tube, termed the draw-tube, into the further end of which the ocular fits. This draw-tube should bear a scale graduated in millimetres to indicate the exact distance of the ocular from the objective. Tube lengths are corrected either for English or Continental objectives; but apart from this, the total length of the tube to be used depends on the thickness of the cover-glass employed during the examination. With Continental instruments, which are intended for use with cover-classes 0·15 to 0·20 mm. thick, the distance from the eye glass to the end of the tube into which the objective is screwed should be 170 mm.; but as a nose-piece is usually employed, and has a thickness of 10 mm., the draw-tube is to be extended to the mark 160. The tube length for the English body is 250 mm. Mention may also be made of the fact that some objectives are fitted with "correction collars" for the correction of the varying thickness of cover-glasses.

Focussing Adjustments.—The body of the microscope with objective and ocular is raised from or lowered towards the stage by two means—the coarse and the fine adjustments. The former is effected either by a rack and pinion, or simply by a combined sliding and screwing movement of the body tube in a spring tube connected with the stand. The mechanism for slow movement of the body, *i.e.* for fine adjustment, varies in its component parts according to the model of the microscope, but usually consists of two tubes which tend to separate from each other by the pressure of a spiral spring, and are moved on each other by a screw attached to a milled head.

The nose-piece, which is an appliance screwed to the lower end of the microscope tube, and permits of objectives being rapidly changed, is an almost indispensable part of the microscope. A nose-piece is usually constructed to carry two or three objectives (double or triple nose-piece).

The illuminating apparatus consists of a plano-concave mirror, and usually, too, of a condensor, whilst the number of rays of light falling on the object is regulated by means of a diaphragm. The mirror can be tilted to any required angle, and is usually mounted on a movable arm so as, if necessary, to give oblique illumination, which is sometimes advantageous when finer structural details have to be determined. *Diaphragms,* which are pieces of metal with an aperture, are employed in order to intercept the peripheral rays reflected from the mirror. If no condensor is employed, the diaphragm is situated immediately below the stage, and is then either a circular copper plate pierced with circular openings of different diameters, and is so attached to the under surface of the stage that any one of these openings can be brought directly beneath the aperture in the stage, or there is an iris diaphragm, the aperture of which can be regulated by a small knob or handle projecting from the side of the diaphragm. Some microscopes, however, are supplied with movable plug diaphragms which are to be inserted into the aperture of the stage, each diaphragm having an opening of different diameter. When the microscope has a condensor the diaphragm is usually of the iris form, and is fitted beneath the lenses of the condensor.

The condensor is constructed of a system of lenses mounted in a tube and placed beneath the stage. The condensor should be capable of being lowered or elevated so that the rays of light proceeding from the mirror may be focussed on the object resting on the stage. This focussing is preferably effected by a rack and pinion; but in the simpler condensors it is performed by means of a simple screw at the side of the condensor. The Abbe condensor is the one in most general use.

Accessory Fittings.—A mechanical stage is one which can be moved mechanically. The better microscopes are fitted with such a stage, but otherwise one can be attached to any ordinary microscope. The movements should be effected by rack and pinion adjustment, and in some models the stage can be concentrically rotated.

For the determination of the size of microscopic objects a special piece of apparatus, the micrometer, is required. In its simplest form this is an eye-piece micrometer—a glass disc on which there is a graduated scale.

A drawing apparatus, or *camera lucida,* is essentially a prism situated in front of the ocular; and the use of such an apparatus, whether in its simpler or more elaborate form is of great assistance when a drawing of a microscopic object has to be made.

The simple microscope is composed of two plano-convex lenses separated by a diaphragm. The lenses are mounted on a stand which has a stage, a mirror, and rack and pinion focussing adjustment. Most of the microscopes of this form magnify from 10 to 20 diameters, and are chiefly of value as dissecting microscopes.

If a microscope is to be purchased it should be obtained from a first-class maker, but need not necessarily be an elaborate instrument. The stand should be a good one and be inclinable; have fine adjustment and coarse adjustment by rack and pinion, a sub-stage condensor with mechanical adjustment, a high- and a low-power objective ($\frac{1}{2}$-inch and $\frac{1}{6}$-inch, or III. and VII.), a triple nose-piece, and two oculars (I. and IV.). Such an instrument will suffice for all ordinary clinical and histological work; and a $\frac{1}{12}$-inch homogeneous immersion objective, a mechanical stage, and other accessories can be obtained subsequently as the need for them arises. The prices and illustrations of the different grades of microscopes of objectives, oculars, and other constituent parts, and also of the supplementary apparatus, will be found in any of the makers' catalogues.

The Use of the Microscope.—Work should, as far as possible, be carried on by daylight. The microscope is to be placed near a window facing north, and for choice the mirror should reflect light from a white cloud; in ordinary work direct sunlight is never used. If artificial illumination is required, an ordinary petroleum lamp with a flat flame, a Welsbach light, or an incandescent electric lamp with a ground-glass shade are most suitable. The microscope should stand on a firm table, and unless objects mounted in fluid are to be observed, the stand should be inclined, so that the head of the observer, who should be seated, is not kept in a strained position. The eye which is not applied to the ocular is to be kept open, in order that the observer's accommodation may be as completely relaxed as possible.

An examination should commence with a low-power objective—a $\frac{1}{2}$-inch or a No. III., if using, say, a Leitz objective—and a low-power ocular, as for instance, a No. I. or No. II. The object mounted on a slide and covered with a cover-glass is placed on the stage, and a diaphragm of medium size having been inserted, the object must now be properly illuminated. If no condenser is used, the plane mirror is to be employed with low-power objectives, the concave mirror being reserved for the $\frac{1}{6}$-inch or other high-power objective, and the axis of the mirror is so adjusted that the greatest amount of light is reflected on to the object. This is then focussed by the coarse and then by the fine adjustment. If a more highly-magnified view of the object be then desired, the microscope tube is slightly raised from the stage and the higher power objective, *e.g.* the $\frac{1}{6}$-inch, is revolved on the nosepiece till it is brought into position, when the object is once more focussed.

If a condensor be employed, as is always desirable, the light is invariably to be reflected from the plane mirror, except when very low-power objectives are in use. The light being reflected from the plane mirror on to the object, the latter is carefully focussed, a suitable diaphragm is inserted, and the rays of light reflected from the mirror must then be accurately focussed in the plane of the object, and to do so the condensor is to be raised or lowered until the image of the source of light is seen as sharply as possible at the same time as the accurately focussed object. When the condensor is used with artificial light, the object is first focussed and the image of the flame is directed to the middle of the field, and the condensor is then lowered or raised until the image of the flame is focussed in the plane of the object.

The object can then be studied with the greatest precision; but for most purposes it is more convenient if the condensor be lowered until the field is evenly illuminated.

With an oil-immersion objective the condensor and plane mirror are always to be used. The slide is placed on the stage so that the optical axis of the microscope coincides with the centre of the cover-glass, on which a drop of cedar oil is now placed. The tube of the microscope is then lowered until the objective is observed to touch the oil. The observer then looks through the microscope, throws the light from the mirror on to the object, and carefully racks down the microscope tube until the object comes into view, when the coarse adjustment is discarded and the object focussed by means of the fine adjustment. The illumination has now to be regulated, so that the rays of light passing through the condensor shall unite in the plane of the object, and to do so it is convenient to employ the method of "maximum illumination," which consists in simultaneously regulating with the left hand the position of the condensor, and with the right hand the mirror in such a manner that the centre of the field is illuminated as brightly as possible. The same result can be obtained by removing the ocular and, whilst looking down the tube of the microscope, simultaneously regulating the condensor and mirror so that the uppermost lens of the objective is most clearly illuminated, the centre of the illuminated portion corresponding to the centre of the lens. After replacing the ocular the illumination of the field will then be found to be as correct as it was by the previous method.

As regards the diaphragm to be employed in each instance: if objects which are differentiated solely or chiefly by different refractive indices—for example, bacteria suspended in fluid—are to be observed, the iris diaphragm is to be contracted; whereas if objects are to be recognised by their colour, the diaphragm must be opened as widely as possible. In order to ascertain whether full use is being made of the aperture of the objective, the observer removes the ocular and notes whether the uppermost lens of the objective is illuminated to its margins or whether only the central portion is illuminated.

The Care of the Microscope.—The instrument when not in use should be protected from dust by a glass cover. It is convenient to have a cord running in a pulley fixed to the ceiling and to attach the upper end of the glass cover to one extremity of the cord, whilst a piece of lead of the same weight as the cover is suspended freely from the other end. The cover can thus be raised off the microscope and again lowered with great facility. Dust and stains on the stand should be removed by a fine clean cloth; alcohol should never be applied for the purpose of cleansing the stand as it will remove the lacquer from the brasswork. If the joints require oiling, clock oil is suitable for the purpose. Objectives should be examined both before and after use in order to ascertain whether they are clean. This is preferably done with the aid of a pocket lens, but the ordinary low power objective serves equally well for the same purpose and is always at hand. Dust on the ocular is detected by rotating the latter in the draw-tube. If on so doing the dust particles remain in an unchanged position in the field they are probably on the objective and are removed by means of a fine, soft, linen rag, or piece of chamois leather which has been thoroughly washed. If a dry cloth prove insufficient to cleanse the lens, it should be wiped with a cloth moistened with distilled water, or a *little* alcohol or benzine. Xylol should not be used, as it tends to act on the balsam cementing the lenses. After using the oil-immersion objective it should always be cleaned and dried with a small piece of cotton wool or fine linen.

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Micturition.

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See also URETHRA, HÆMATURIA, URINE.

INTRODUCTORY.—Under normal circumstances in the healthy adult the act of micturition is performed about four times in the twenty-four hours, and the interval of sleep is exempt from the necessity of the individual voiding urine. While this is so, we must note that the influence of habit is capable of modifying this function without of necessity indicating a diseased state. More especially is this so in the female sex, where the bladder is relatively more capacious, and in whom custom induces less frequent micturition. At birth the infant may pass water very shortly after birth, as the urine is secreted during the later months, but not infrequently the infant passes the first twenty-four hours without micturition. During the early months of life the normal condition is one of incontinence. During the first eighteen months the infant passes water usually about twice every hour, except during sleep, when the urine may be retained for two or even three hours. As the child grows the intervals between micturition lengthen. In this respect much depends on careful training. With judicious nursing an infant acquires some control over its bladder within a year or eighteen months.

Physiology of Micturition.—A knowledge of the physiology of the act is essential for a due understanding of the disorder. The mechanism concerned in normal micturition, which is a voluntary act, is as follows:—There are two centres in the lumbar region of the cord—a sphincter centre and a micturition centre, the former controlling the sphincter at the neck of the bladder, the latter influencing the muscle fibres of the bladder wall. These two centres are in turn under the control of higher centres in the cerebrum. When the bladder gets distended the mucous membrane is stimulated, and an apparent impulse passes through its nerves into the cord to the sensorium. When this is perceived a double impulse is emitted from the brain to the centres in the cord: one to inhibit the sphincter centre's activity, and so allow of relaxation of the neck of the bladder, the other to stimulate the micturition centre and so bring about expulsion of the bladder contents. In the case of involuntary micturition the mechanism is somewhat different.

This takes place independently of the controlling influence of the higher centres. When the bladder gets distended the impulses gradually accumulate in strength, and, acting on the nerve endings in the neck of the bladder, in themselves suffice to lead to relaxation of the sphincter, and at the same time induce partial stimulation of the muscular fibres of the bladder.

Frequency of Micturition.—The first point to emphasise about this symptom is the fact of its being one both of surgical and medical importance. If we apply the knowledge of the physiology of the act just given we will readily understand that any abnormal state of the mucous membrane of the bladder may induce this symptom, which is often a distressing one. Of these the more common causes are cystitis, enlargement and other affections of the prostate, urethritis, stricture, and the presence of foreign bodies, *e.g.* calculi. In women, in addition to the actual state of the urinary tract itself, we have to consider the operation of a number of other causes acting primarily outside the urinary tract. These include malpositions of the uterus, tumours in the pelvis, early and late pregnancy, etc. We must also remember the more strictly medical aspects, and investigate carefully the state of the kidneys and also the general state of nutrition. If we mention chronic nephritis and calculous pyelitis, we have good examples of kidney lesions that may be the causal factors, and in the various forms of diabetes, hysteria, etc., we find constitutional states that may be the determining factors of the condition. A statement of these facts will clearly indicate the necessity of very carefully investigating each case along general as well as special lines. We must further remember that in later life it is by no means uncommon to find cases of frequency that are dependent, partly on a local condition, *e.g.* enlarged prostate, and partly on a more general state, *e.g.* renal cirrhosis. This point will influence alike the diagnosis, prognosis, and the treatment.

Retention of urine is the result of mechanical obstruction, and must not be confounded with suppression, which implies a failure of secretion (see "Urine"). Its most common cause is a stricture of the urethra (*q.v.*). Enlargement of the prostate may cause retention at one time, frequency of micturition at another, and incontinence at a third. In the early months of pregnancy retroversion of the gravid uterus may cause complete retention, which may also occur after an operation such as for hæmorrhoids, torn perinæum, and the like.

In children a tight prepuce or an impacted calculus, or rectal irritation by thread-worms, may be causal factors. The first-named is specially to be noted, as well-marked cases of hydronephrosis have been known to arise as a result of this form of obstruction.

Incontinence of Urine in Children.—This is a common condition in children. It is most frequently seen in nervous and emotional children, but is also seen in those with no obvious personal nor hereditary neurotic tendencies. As a rule, with advancing years the tendency gradually lessens and then finally disappears, but in some instances it continues without change until puberty and then gradually disappears. If persistent, the possibility of the existence of some congenital defect in the bladder or urethra should be kept in mind; this holds good especially for girls. Mention need only be made of the existence of incontinence as a symptom in many severe organic diseases of the nervous system. In these diseases the incontinence may be due to a disturbance of the centres and nerve roots in the lumbar cord, or to a loss of the higher controlling mechanism. In many cases a disturbance of both these functions prevails.

Nocturnal Incontinence.—This is the most troublesome form of the disorder. In spite of all precautions that may be taken, and even if the child is most anxious to assist in the matter, a quantity of urine is passed involuntarily during the night. It is important to emphasise the fact that in the great majority, if not indeed in all of these cases, the child cannot be blamed, and therefore should not be in any way punished for this misfortune. What appears to occur is that during sleep, whenever the bladder becomes even slightly distended, a reflex action is set up, and involuntary micturition occurs. Not infrequently the tendency is aggravated by local irritation, *e.g.* phimosis, worms, or injudicious dietary, with resulting irritation of the solar plexus. In a highly-strung child any emotional excitement before going to bed will predispose to its occurrence. The treatment of this class of case is simple, but sometimes unsatisfactory. In the first place, we must look for any source of local irritation such as already indicated, and if that be present it must be suitably corrected. If nothing of the kind can be made out, we may try one or more of the following, which are all useful:—(*a*) Three to ten, or more, grains of bromide of potassium or sodium in conjunction with five to ten minims of tinct. belladonna in a little glycerine and water half an hour before bedtime; (*b*) a belladonna plaster applied to the lumbar region; (*c*) a hot fomentation applied to the belly. The patient should also be made to sleep on a slightly filled water-cushion.

Incontinence in Adults.—True incontinence must be distinguished from that due to dribbling from an over-distended organ. An examination of the hypogastric region will readily reveal the latter condition. In elderly men this symptom is in the great majority of instances due to irritation from enlarged prostate, and calls for treatment by the use of the catheter. In this class of case, however, it is surprising what benefit may be obtained by educating the patient to *fully empty* the bladder. This is a point of considerable value, and its recognition and practice will often be attended with gratifying results; its value to the patient is great, not only for the temporary relief afforded him, but from the diminution of the risks associated with a catheter life.

In women care must be taken not to confuse a distended bladder with an ovarian or parovarian cyst.

True incontinence is a frequent symptom in cases of gross lesions in the central nervous system. Its recognition is easy, and its treatment is apt to be as unsatisfactory as that of the primary disease.

Diminished Size of Stream.—This may arise from a congenital narrowing of the external meatus, or from an enlarged prostate, or stricture of the urethra, interfering with the discharge of a normal volume of water. Other factors bearing on this are considered in other articles (see "Hæmaturia," "Urethra").

Pain on Micturition.—A consideration of the various conditions giving rise to painful micturition (dysuria) falls outside the scope of this article. As the determining factors are of local origin they are found discussed in other sections (see "Bladder," "Urethra," "Hæmaturia," etc.).

Migraine, or **Megrim,** is a paroxysmal form of headache allied to epilepsy and other nervous diseases (vol. iv. p. 315). In its most characteristic form it is unmistakable and readily recognised, but in its less developed forms it may be more difficult to differentiate from other forms of headache (*q.v.*) and neuralgia (*q.v.*). Alike in its minor and major forms it bears a close relationship to gout (*q.v.*), a disease in which the uric-acidæmia, so called, is only a symptom and not the cardinal factor that is often supposed. Gowers describes a type of case in which visual disturbance, like that preceding attacks of megrim, occurs frequently during many years as an isolated symptom. The writer has met at least one similar case in a young woman with a pronounced gouty family history, she herself having occasionally suffered from acute gout in its slighter degrees. In this case a cholagogue plus a saline cathartic gives early relief. There is no doubt that the megrim is a toxæmia, and a present desideratum in our knowledge is the state of the blood before, during, and after the paroxysms. Such an investigation would probably throw not a little light on some points in the etiology of the disease. The diagnosis and treatment of the condition is fully considered in another section (see "Headache"). It is perhaps here advisable merely to draw particular attention to the important part probably played by the digestive tract and the liver in the development of this condition. If from any cause the power of the intestine to resist invasion by toxines formed by bacteria in the alimentary canal, but not under normal circumstances absorbed, be lowered, an absorption of these toxic substances may occur, and this absorption may initiate a disturbance in that part of the patient's system that has naturally a low resisting power. A somewhat similar action may induce a state of hepatic inadequacy, which in turn will lead to an aggravation of the symptoms. Hence treatment directed primarily to the bowels and liver is of primary importance, and is more likely to be attended with success than treatment directed specially to nerve tonics and the like.

LITERATURE.—LIVEING, EDWARD. *Megrim, Sick Headache, and some Allied Disorders.* London, 1873.—GOWERS. *Diseases of the Nervous System.*

Miliaria.—*Definition.*—The term "miliaria" is applied to those cutaneous disorders in which a fine papular, or vesicular, eruption accompanies a visible accumulation of sweat in any portion of the surface of the body. Mention is made in works on dermatology of miliaria crystallina, M. rubra, M. vesiculosa and M. papulosa, but, with the exception of crystallina, they are mere clinical expressions of uncertain pathology.

SYMPTOMS.—1. *Miliaria Crystallina or Sudamina.*—In the course of scarlet fever, typhus, puerperal fever, acute articular rheumatism, and many other febrile and inflammatory diseases, we not uncommonly meet with an eruption of vesicles at the so-called critical stage, when an outburst of perspiration follows the temporary arrest of the sudoriparous function. This vesicular eruption is miliaria crystallina or sudamina, and is due merely to the retention of sweat in the ducts immediately beneath the thin, horny cuticle. The vesicles resemble drops of dew inasmuch as they are pellucid and colourless, and are not unaccompanied by hyperæmia or inflammation. They provoke no subjective symptoms, although they may develop in large numbers over the neck, chest, and abdomen. The vesicles have no infective power, and once developed, cease to enlarge. In a few days they dry up, the damaged fragments of cuticle fall off, leaving no trace of the eruption. Sudamina is not a special exanthema and has no diagnostic or prognostic importance.

2. *Miliaria Rubra.*—While it is not yet clear as to what precise morbid condition of the skin this term should be restricted, M. rubra undoubtedly belongs to the group of eruptions which accompany profuse sweating. The lesions are bright red papules or minute vesicles, according to the amount of fluid in the skin, and they generally develop in crowds closely set together over the chest and abdomen, or any portion of the skin which may have been overheated. The vesicles remain isolated even when crowded together, unlike the eczematous lesions which have a strong tendency to fusion, and after a few days disappear without leaving any marks of their existence. The eruption as a whole, may be kept up for some weeks if the hyperidrosis and surface irritation are allowed to continue. Miliaria rubra is not uncommon in children as a result of too warm clothing; it is known in such instances as *strophulus,* or "red gum," or lichen infantum.

3. *Miliaria Alba.*—This is not a special disease. The name refers to

the milky-white appearance which the miliary vesicles sometimes assume. It is due to the macerating influence of the fluid on the epidermic layers, or to the conversion of the vesicle into a pustule.

4. *Miliaria Papulosa or Prickly Heat.*—The hyperidrosis underlying prickly heat is not in itself a morbid process, being merely the effect of a hot climate. It is mainly in the tropics that this affection is found, although it is not unknown even in temperate climes during a hot summer. Europeans are prone to prickly heat, especially during their first year in a tropical country. Stout and well-nourished persons are more liable to it than the lean and spare. Nude natives of the tropics are probably never affected with prickly heat, but this is true only so long as they remain nude or wear the thinnest of cotton garments. The eruption has been observed to develop under the belt in Sepoys who wear khaki uniform. The eruption consists of crowds of finely-pointed papules, of a bright red colour, which develop at or near the mouths of the sweat ducts on any part of the body surface which is over-heated and irritated by clothes. The sensations arising from the eruptions are made up of pricking, burning, tingling, and irritation, which is sometimes maddening. According to Dr. Martin, formerly of Calcutta, prickly heat is not always accompanied by an eruption. The symptoms tend to subside when the individual is cool and sits quiet, but as soon as he takes exercise or drinks any stimulating fluid the eruption becomes elevated and the distressing sensations return.

PATHOLOGY.—The morbid anatomy of Sudamina, or M. crystallina, has been investigated by Haight, Robinson, and Török. There is a general agreement that the vesicles are essentially sweat vesicles directly connected with the sudoriferous duct, and developing *within* the horny layer of the skin. Pollitzer does not distinguish between M. rubra and prickly heat, using the two names synonymously. But a close examination of his histological report on "Prickly Heat" furnishes reliable evidence of the incorrectness of this view. Pollitzer's report is based on the microscopic examination of pieces of skin taken from eight persons, all of whom presented eruptions associated with profuse sweating. But this author states that neither clinically nor histologically could he find any evidence of the existence of the inflammatory papule. We may conclude from this that the sweat eruptions which form the groundwork of his histological examination were not examples of prickly heat, since it is universally recognised that the small pointed papule is the most characteristic lesion of this affection. Pollitzer's cases were probably examples of miliaria rubra, and his report is valuable as affording some histological grounds for separating M. rubra from prickly heat. The essential changes in M. rubra were found by this observer to consist in cyst-like expansions of the sweat-ducts beginning in the horny layer, and situated one below the other throughout the whole thickness of the rete. This cystic formation was found unaccompanied by any signs of inflammation, but the horny layer was œdematous and nucleated. The character of the contents of these cysts varied with their ages, being wholly fluid in those of recent origin, while the older ones were packed with epithelia and round cells and nuclei. The most frequent situation of these cysts was just above the stratum granulosum. Their anatomical connection with the sweat ducts was proved to the satisfaction of the author. The pathology of M. rubra is still further complicated by Török's investigations. According to this author and Unna, the vesicles of M. rubra have no connection with sweat ducts, but develop in the deep layer of the stratum corneum. Török found evidence of circumscribed papillary inflammation, and therefore concluded that the vesicles were purely inflammatory and not sweat cysts. The truth probably lies midway between these two opinions—namely, that while the vesicles of M. rubra may be retentive sweat cysts, they are in some instances, where external irritation has supervened, of inflammatory origin and unconnected with the sweat ducts.

Etiology.—The cause of the retention of sweat in sudamina is probably a collapse of the horn structure at the orifices of the sweat-pores during the height of the fever. In M. rubra the hindrance to the dispersion of sweat is supposed by Pollitzer to be due to the imbibition of sweat by the horny layer, and the consequent swelling and blocking up of the mouths of the sweat ducts. This, however, is a doubtful explanation, for, as Unna points out, sweat cysts do not develop in cases of maximum swelling of the stratum corneum by water and alkalies as met with in washerwomen. The eruption in prickly heat is clearly attributable to the irritation of clothes, when the amount of sweat passing through the skin is greater than can be readily dispersed by evaporation.

Treatment.—Sudamina calls for no treatment. In M. rubra it is necessary to keep the skin cool and to apply some astringent such as calamine or lead lotion. In prickly heat the most rational procedure is to reduce the excessive perspiration by keeping as cool as possible, avoiding active exertion during the hottest period of the day, and in clothing the body in cool raiment. Linen garments should be avoided, and especially when starched. Diet should be light and non-stimulating. According to Dr. Martin, the cold bath only aggravates the complaint by increasing the cutaneous circulation. Warm alkaline baths are recommended by some, while cool saline drinks are useful on account of their diuretic action. Locally, a cool drying lotion or ointment will usually give relief.

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Milk.

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Section I.—Industrial

Milk Production.—The quantity and quality of the milk depend on, *inter alia*, breed and age, feeding and shelter, and are influenced by climate and weather. The British farmers prefer the *Shorthorns* and *Ayrshires* as being very hardy, giving much milk, though not rich in fat, and fattening well when done with. The Ayrshires will thrive on the poorest pasture, but well repay care; their pugnacity is, however, against them. *Devons* give a richer milk and plenty of beef, and the docile hornless *Red-polls* are good milkers, but bad graziers. The best for butter-making are the little black *Kerry* cattle, very hardy and splendid milkers; and the *Guernseys* and *Jerseys,* alike remarkable for the golden yellow colour of their butter. These two breeds are quite distinct, and their purity is maintained in their native islands by local legislation, but in England they are often crossed with hardier breeds, for the delicacy of their constitution necessitates their being housed for more than half the year, and renders them peculiarly liable to contract tuberculosis.

All cows should be dried for two months before calving; the quantity of the milk is greatest before the eighth week after, but its quality improves subsequently. In cold weather they should be sheltered at night and the more tender breeds by day, though open sheds suffice for the hardier. The Scotch practice of putting up movable shutters in front, leaving about three feet open above, answers well for most, and in such sheds the question of cubic space need not be considered. Some shelter should be provided against rain, for, apart from the suffering involved in exposure to cold and wet, it is economically unwise, since the food that would otherwise go to milk is employed in maintaining the body heat. The warmer they are kept the more milk they yield, but this must not be achieved at the cost of ventilation and cubic space.

Cow sheds—called "shippons" in the northern counties, and "byres" in Scotland—are, as a rule, most insanitary. Cleanliness and ventilation are even more necessary than warmth. At least 1000 cubic feet should be allowed to each cow, exclusive of gangways, and free ventilation secured by ample openings in the front wall, closed against snow or extreme cold only; louvred apertures in the opposite walls, well above the heads of the animals, and in the roof, over which there should never be a loft. The floor should be of hard pavior bricks or rough concrete—not of cobbles which cannot be kept clean—and slanting to a well-laid gutter of glazed half pipes or moulded in concrete, with sufficient fall, leading to a tank, no trap being interposed. It should never discharge into a pond or ditch. The cost of the tank will be nothing compared with the value of the liquid manure produced by the urine and dung carried down with the washings.

In tying up the cows their heads should not be close to the wall, for they are apt to bespatter it with their nasal mucus, and one tuberculous cow will thus infect others occupying the same stall after her. To avoid this a space of three feet should intervene between the feeding troughs and wall, which, besides its sanitary advantages, permits of the troughs being replenished without disturbing the cows, whence it is commonly known as a "feeding walk." When the cows are indoors for many hours drinking troughs should be provided, supplied by pipes from a cistern. The litter should be removed daily, the floors being washed down during the change.

The strawyard, as commonly met with, is sanitarily an abomination and economically a blunder. It should be kept as clean and dry as possible, well paved with concrete, not rough stones, and drained into the same tank as the cow-houses and sheds. Drinking troughs, supplied from a cistern and frequently cleaned, should be mounted three or four feet from the ground, so that the cows shall not foul the water with their urine or dung. The practice of allowing cows to drink from ponds fouled with urine and sewage is detrimental to their milk, if not to their own health; that they will do so, and especially when ill seem to prefer it, is probably due to a craving for salt, which might well be provided with their food. No dung heaps or dung pits, or collections of filthy water, should be permitted in proximity to the milking-place or dairy.

The process of milking is too often disgusting and disgraceful; the admixture of dung from the flanks and udders of the cows and the hands of the milkers being palpable, and, apart from its loathsomeness, inducing early souring of the milk. Cows when in sheds should, in fact, be groomed almost like horses; and, before milking, their udders and the milkers' hands washed and wiped dry, warm water being provided in winter.

The dairy should be spacious, cool, airy and light, sheltered from the mid-day and afternoon sun, and ceiled with an airy roof loft above it. The floor should be smooth and impervious, of glazed tiles laid in concrete, for spilled milk on an uneven floor, breeding bacteria, tends to cause souring of that stored in the place. The drain should, for the same reason, be open and trapped outside, not within. All milk must, immediately after being drawn, be passed over a Lawrence's refrigerator worked by water drawn directly from a well or main at the lowest possible temperature. Milk thus chilled within five or ten minutes may be sent any distance by road or rail, and will remain sweet for twenty-four hours, when it would otherwise be spoiled or even poisonous. In the best German dairies it is not only strained through muslin to remove hairs, insects, etc., but with the pressure obtained by its descent from an overhead tank, it is filtered upwards through a cylinder divided by perforated diaphragms into four compartments—the upper three being filled with sand. Not only every particle of dirt, but 50 per cent to 70 per cent of the bacteria are thus removed, while the loss of fat is inappreciable. The sand must be cleaned daily with boiling water and frequently renewed.

Influence of Food.—Milk containing a high percentage of each of the three food stuffs, and fat being for the most part a product of the metabolism of albumin, the need for a diet rich in albumins is evident. Wolff gave the best nitrogenous ratio as 1:5, but, excluding amides, we may put the ratio of albumin to the other solids as 1:6 to 8, according as a rich or an average milk is desired, *e.g.* as when butter or milk production is the object in view. This is approximately presented by pasture grass and clover hay, and by oats and maize, while in ordinary meadow hay and other cereals it is 1:9. Bean, oat, and wheat straw give respectively 1:12, 20, and 27, and roots about the same, varying with age and soil. When, as in winter, these enter largely into the fodder, they must be supplemented by other foods containing higher proportions of albumin, as pease and beans, 1:2·5 – 2·75; cotton cake, 1:3·5; linseed, 1:2·5; and decorticated cotton, 1:1·25. Though fat in the food, as Kühne's experiments proved, has no influence on that in the milk, its value in nutrition is great. Calculated on the total solids, roots contain but 2 per cent; hay, straw, pease, and beans, 2 per cent to 3 per cent; grass, 4 per cent; maize, oats, and cotton cake, 5 per cent to 6 per cent; decorticated cotton, 15 per cent; and linseed cake, 12 per cent to 24 per cent. Turnips give an unpleasant flavour to the milk, as do grains, which, as well as silage, render it unwholesome, especially to infants, and are prohibited by the best dairy companies and condensed milk factories. Hay should be cut as soon as the bloom is out; for the nutritive value rapidly deteriorates. Lawes and Gilbert found that in successive cuttings from the same meadow under equally favourable conditions, the woody fibre increased between 14th May and 26th June from 22·97 per cent to 38·15 per cent, while the nitrogenous substances fell from 17·5 per cent to 8·46 per cent, and the fat from 3·19 per cent to 2·71 per cent.

Spoiling of Milk.—Bacteria multiply more rapidly the warmer the milk, but odours are more readily absorbed when it is cold, for cold air coming in contact with warm milk expands, and rising may even serve to remove the "cowey" odour.

The Creamery.—The old method of exposing the milk in shallow pans and skimming off the cream as it rose is now well-nigh obsolete, for the separation is imperfect and so slow that some degree of souring takes place meanwhile. The well-known fact that the cream rises most rapidly when the temperature of the milk is falling, owing, as Professor Arnold explained, to the greater conductivity of the watery portion increasing the difference between its density and that of the fat, is taken advantage of in the "Jersey" creamer, a shallow tank of enamelled metal with hollow sides and bottom; the jacketting is filled with hot water, which when the milk has become warm is exchanged for cold; the cream then rising rapidly, the subjacent milk is run off through a tap in the bottom, and the cream removed in like manner, or by tipping up the tank.

But "separators" or centrifugalisers worked by steam or gas engines, and performing 3000 to 6000 revolutions per minute, have almost entirely superseded all other methods for efficiency and rapidity, from the facility which cream of the desired thickness can be secured, and the sweetness of the separated milk, since the cream can be obtained from perfectly fresh milk. The composition of cream varies greatly, the fat being from 20 per cent to 30 per cent, with extremes of 10 per cent and nearly 70 per cent, but the other solids are present in the same proportions as in milk. Its "viscosity" depends rather on the size of the fat globules than on the actual percentage of fat, though it is artificially thickened by a solution of cane sugar in lime water, known in the trade as "viscogen." "Devonshire," or clotted cream, raised spontaneously from milk, kept for many hours at a temperature of 120° to 160° F., contains 60 per cent to 70 per cent of fat, and more than the normal amount of casein and coagulated albumins.

All "spontaneous" changes occurring in milk are the work of bacteria, some converting the sugar into lactic acid, others coagulating the casein with, or, as in the preparation of the German sauermilch, almost without souring, and others again setting up putrefaction, or even developing poisons, as tyrotoxin without other appreciable alteration.

"Ropy" milk is due to the action of certain bacteria on the casein, and abnormal colours, as blue milk, green, red, and an unnatural yellowness, to the growth of bacteria introduced from without or present in purulent secretions in the udders themselves.

SECTION II.—PHYSIOLOGICAL

The milks of all mammalia consist of water holding in actual or virtual solution salts, sugar, casein, and other albumins, with minute globules of fat uniformly suspended, though tending to rise in consequence of their lower spec. gravity. The proportions, absolute and relative, of the several constituents vary, those of the fat especially, but within narrow limits, so that the composition of the milk is fairly constant for the species, the race, and the individual. Casein is an albumin, but possesses characters distinguishing it from the others, as its coagulation when acted on by the gastric secretion, but not by heat, and the casein of one animal differs from that of another. Ignoring those of the carnivora, rodents, etc., with which we are not concerned, milks fall under two types: (1) the ruminant, (2) the human, the asinine, and the equine. Save as the source of the original kumys mare's milk has no dietetic interest, being too laxative for ordinary use. The essential difference between the milks of the first and second types is not so much in the percentages of the sugar and fat, as in the character of the casein, and the actual and relative proportions of the caseins to the other albumins. Though the importance of fat in nutrition cannot be too strongly insisted on, that of the digestibility of the albuminoids is still greater in the first three or four months of life. And Klemm, von Ranke, and Parrot have proved conclusively the superiority of asses' milk over any preparation of that of the cow in rearing premature and feeble infants notwithstanding its deficiency in fat. The casein of cow's milk forms in the stomach a dense and hard curd, whereas the coagula of human and of asses' milk are soft and flocculent; and human casein, as Wrobelewski finds, does not, like that of the cow, give rise to the indigestible nucleins. The practice of reckoning all albuminoids as casein without distinction is a grave error in dietetics, and accounts for the failure of most attempts at accommodating cow's milk to the requirements of infancy. It is easy enough by diluting cow's milk, thus reducing the percentage of sugar, casein, and fat, and adding sugar of milk, to obtain a milk identical on paper with mother's milk, but the difficulty arising from the indigestibility of the casein remains.

The only procedures meriting the description of "humanising" are those that aim at combining a maximum of the fat and of the albumin, which, explain it as we may, for the most part goes over with it, and a minimum of the casein. The most perfect process is that of Professor Gaertner, which consists in the slow centrifugalising of warm diluted milk, to the richer portion of which milk sugar is added, and the whole made up by further dilution to the proper volume.[1] Some dairy companies achieve the same result by substituting for the centrifugalisation a modification of the Jersey method of raising cream, and lastly, it may be imitated, though less perfectly, by adding cream and milk sugar to freely diluted milk. But the small table separators worked by hand are well suited for Gaertnerising at home, and no other process approaches it in the precision and constancy of the result. Save as regards the cow, the discrepancies in the published analyses of the milks of different animals are so great as to deprive them of much value, but this is not of such importance as it might appear, since though later on a growing infant requires a "rich" milk, in the first three months of life the casein question casts all others into the background.

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[1] Good fresh cow's milk, diluted with an equal volume of hot water, is centrifugalised at such a velocity that the richer and poorer portions pass over at the *same rate;* milk sugar is then added to the richer half in the proportion of 35 grams to the litre, *i.e.* 310 grains or five drachms to the pint (and for infants under one month, one part of barley water to two or three of the milk).

The following may be taken as averages from the best analyses :—

Animal.	Water.	Casein.	Albumin.	Fat.	Sugar.	Salts.
Cow	87·0	3·3	0·4	3·8	4·8	0·7
Goat	86·0	3·5	0·9	4·6	4·3	0·7
Woman	88·0	1·0	0·7	3·3	6·8	0·2
Ass	90·0	0·9	0·6	1·2	6·8	0·5
Mare—						
König . . .	90·7	1·25	0·75	1·17	5·7	0·37
Vieth . . .	90·0	1·9		1·1	6·7	0·3
Fleischmann .	91·0	2·0		1·0	5·6	0·4
Seeland: taken on the steppes	91·42	2·93		1·82	3·6	0·22

The greatest doubt attaches to the differentiation between the casein and the albumin in human milk, and Hauser gives for woman's milk the inverse proportion of casein 0·77 and albumin 1·59.

SECTION III.—DIETETIC

Milk is commonly described as a "perfect" food, and rightly so if it be meant that it is the only article of food capable alone of sustaining life at all ages, and, with the sole exception perhaps of cocoa, which, like it, contains all the three food stuffs in sufficient proportions, at all ages subsequent to infancy. But they are not present in the relative proportions required by the adult under normal conditions; the excessive amounts of water and albuminoids inducing too active metabolism; individuals, as diabetics, have indeed been known to accommodate themselves to an exclusively milk diet, but it is only when growth and flesh formation, which involve a corresponding activity of metabolism, are proceeding rapidly, as in infancy and in repair during convalescence from wasting diseases, that milk is, in the strictest meaning of the word, a perfect food. Several milk preparations have of late years acquired an important dietetic interest, the foremost place among these being taken by the condensed milks. Condensation is effected by evaporation of the water by gentle heat, accelerated by the reduction of atmospheric pressure in so-called "vacuum pans," and is carried so far that the volume of the milk is reduced to about one-fourth. One part, therefore, of an unsweetened, with three of water, reproduces the original milk. But the great majority of condensed milks are "sweetened" by the addition of a large quantity of cane sugar, so as to preserve them unchanged for an indefinite period after the cans have been opened, though the unsweetened will keep good for a week if opened by two punctures only in the tin. The composition of condensed milk varies greatly. Pollens found the extremes among the unsweetened to be: water, 26-53 per cent; casein and albumin, 15-26 per cent; fat, 13-20 per cent; milk sugar, 12-18 per cent; and salts, 2-3 per cent. Among the sweetened, water, 12-36 per cent; casein, etc., 8-20 per cent; fat, 8-18 per cent; milk sugar, 11-18 per cent; salts, 1·5-3·8 per cent, and the added cane sugar, 24-40 per cent, or 32 per cent as the average. A large number of brands are now made from skimmed or separated milk, and though the law requires the fact to be clearly stated on the labels, and their use in making puddings be harmless, it is to be feared that their lower price leads to their employment among the poor for infant feeding, and they ought to be marked "NOT FIT FOR BABIES." It cannot be denied that the excess of sugar detracts from their suitability as a food for infants, but many children brought up wholly on condensed thrive well, even better than on fresh cow's milk, while the fact of the milk being sterilised and always free from sourness is no small advantage; and probably the alleged starvation of some infants thus fed is owing to an exaggerated estimate of the condensation leading to the use of quantities far too small. More often they appear to induce excessive fat formation with a tendency to constipation. It is needless to insist on the value of cream, a highly albuminous food, rich in a most digestible fat, for infants and invalids, but the use of separated milk, which is free from the sourness of the old-fashioned skimmed milk, and is sold in many dairies at one penny for a half-pint glass, as a summer drink for older children and adults, deserves to be encouraged. The popular notion that the skimming deprives it of all its "goodness" is a complete misapprehension, the casein and sugar being nutritious enough for those who can obtain their fat from other articles of food, and it is certainly more nutritious and cheaper than beer, to which it is on other grounds to be preferred.

Sterilised Milk.—The simple boiling of milk, of course, effects its sterilisation, and so far from rendering it less digestible really has the opposite effect. Many an outbreak of enteric fever and case of tuberculosis, to say nothing of other diseases, would have been prevented by this simple precaution if the popular prejudice and apathy could be overcome. Domestic and portable sterilisers, as Aymard's, are simply saucepans with water jackets to avoid burning, but those used in large dairies, of which the best is that of Flaack of Brunswick, are steam ovens with manometer, safety valve, and other automatic mechanisms, in which several hundred bottles can be exposed to dry or damp vapour under pressures to two atmospheres and at temperatures up to 125° C. = 265° F., with no perceptible change in the taste or appearance of the milk. "Pasteurising," or continued exposure to lower temperatures, as 70° C. or 160° F., has been abandoned as ineffective.

Peptonised milk is made by the action of peptic or pancreatic ferments on diluted milk at 37° C. = 98° F. for 20 min., when, if not immediately drunk, it should be surrounded by ice to suspend, or boiled to arrest, the process, though for rectal administration, in which the intensely bitter taste produced by prolonged digestion does not matter, it may be continued for an hour with great advantage.

SECTION IV.—THERAPEUTIC

The value of milk as a diet in gastric, renal, and hepatic diseases, in glycosuria, in which lactose is the only sugar or carbohydrate that can be taken with impunity, in convalescence from wasting diseases, and in fevers, is too well known to call for detailed treatment. In enteric fever, however, the coagula are often imperfectly digested, leading to flatus from decomposition in the bowel, and aggravating the general distress and fever, in which cases peptonisation is to be recommended. Diabetic patients may be maintained on a diet of milk alone and be capable of active exertion. In gastric ulcer milk is better borne than any other food (except Leube's dissolved meat), but in severe cases it is well to peptonise it, or to administer pepsin at the same time. Asses' milk is often preferable to that of the cow.

Kumys or *Koumiss.*—The use of this preparation is undoubtedly the most important development of the so-called "milk cures." Used by the Bashkirs of the steppes of Orenburg and Ssamara from time immemorial as a restorative food and a mild alcoholic drink after the deprivations and hardships endured during the winter, it attracted the attention of the Russian physicians, to whom we owe most of the literature on the subject, as long ago as 1830, and thirty years later of the German. At first it was the practice to send patients to live in the tents of the nomads, but the dirt and discomforts of such a life being intolerable, several medical men opened well-conducted establishments at Ssamara, and later at Moscow and elsewhere, with far better results. Koumiss is a white, foamy, slightly sweet, acid and alcoholic refreshing drink, the alcohol increasing until the whole of the sugar is destroyed, a small amount of lactic acid being produced at the same time. Mare's milk, rich in sugar and poor in casein and fat, is the best, but cow's milk can be made available by appropriate manipulation. Koumiss of the highest quality, and, owing to the scientific skill and cleanliness practised, of greater constancy of composition and stability, is now thus prepared in Russia, Germany, and in this country by the Aylesbury Dairy Company, whose late chemist, Dr. Vieth, devoted considerable attention to the subject.

The fullest account, historical and descriptive, of the manufacture and composition of Russian koumiss, its physiological action, therapeutic uses, and the earlier literature, is the appendix by Dr. Stange to Bauer's *Dietetics,* being vol. i. of Ziemssen's *General Therapeutics,* translated by the writer of this article for Smith and Elder in 1885.

Koumiss varies greatly in the percentages of its constituents according to its age, mode of preparation, and the milk from which it is made. The following typical analyses, selected from a large number, show that that prepared from mare's milk is more alcoholic, and that the fermentation as brought about by the Bashkirs is more rapid and complete, the sugar disappearing within thirty hours, whereas, when cow's milk is used more than half remains unchanged at the end of three weeks.

	Dr. Stange. Koumiss as prepared on the Steppes.					Dr. Vieth. Koumiss prepared in England from Imported Mares.		
	Mare's milk.	After 6 hours.	After 13 hours.	After 30 hours.	After 6 days.	After 1 day.	After 8 days.	After 22 days.
Water	90·2	90·90	90·65	91·36	91·36	91·43	92·12	92·07
Alcohol	0·0	1·85	1·95	3·00	3·00	2·67	2·93	2·98
CO^2	0·0	0·38	0·60	0·70	1·10	...	...	...
Sugar	5·1	1·88	1·63	0·00	0·00	1·63	0·50	0·23
Lactic acid	0·0	0·39	0·56	0·64	0·64	0·77	1·08	1·27
Casein	2·3	2·25	2·26	2·00	1·60	0·77	0·85	0·83
Albumin						0·25	0·27	0·24
Albumose						0·98	0·76	0·77
Fat	1·9	1·90	1·90	1·90	1·90	1·16	1·12	1·30
Salts	0·5	0·45	0·48	0·45	0·40	0·35	0·35	0·35

Dr. Vieth gives the results of his analyses of koumiss prepared by himself from cow's milk for the Aylesbury Dairy Company, as follows:—

	Full Koumiss.			Medium Koumiss.			"Diabetic" Koumiss.		
	After 1 day.	After 8 days.	After 22 days.	After 1 day.	After 8 days.	After 22 days.	After 1 day.	After 8 days.	After 22 days.
Water	88·90	90·35	90·57	87·55	88·39	88·62	92·24	92·38	92·55
Alcohol	0·15	0·94	1·04	0·29	0·97	1·05	0·28	0·35	0·57
Sugar	6·03	3·10	2·18	6·80	4·70	3·90	2·78	2·42	1·64
Lactic acid	0·34	0·96	1·40	0·68	1·20	1·67	0·75	0·86	1·22
Casein	2·31	1·96	1·88	1·46	1·40	1·30	2·19	2·13	2·05
Albumin	0·30	0·23	0·20	0·43	0·25	0·14	0·30	0·25	0·13
Albumose	0·34	0·53	0·77	0·48	0·76	0·97	0·36	0·48	0·65
Fat	1·35	1·36	1·38	1·54	1·56	1·58	0·57	0·52	0·57
Ash, sol.	0·17	0·28	0·23	0·28	0·32	0·33	0·22	0·24	0·26
Ash, insol.	0·41	0·34	0·35	0·49	0·45	0·44	0·37	0·37	0·37

Kephir, a similar but less alcoholic preparation, has, according to König, a mean composition of

Water	91·21	Fat	1·44	Albumin	0·36
Alcohol	0·75	Sugar	2·41	Albumose	0·30
Lactic acid	1·02	Casein	2·83	Ash	0·68

But one sample examined by Hammarsten contained 3·088 of fat.

The half-dozen bottles drunk daily in a "koumiss cure" constitute in themselves, as Dr. Stange observes, a scanty diet, but being highly digestible, slightly stimulating, and very refreshing, it assists the appetite for and digestion of other food, as the fat mutton which is a regular part of the course. It encourages the action of the heart, kidneys, and respiratory and digestive organs. It is especially beneficial in impaired nutrition, anæmia, chronic dyspepsia, mucous catarrhs, early phthisis, nervous exhaustion, and convalescence from fevers and wasting diseases. It is contra-indicated in organic disease of the heart and in acute inflammatory and congestive affections of the liver, kidney, uterus, etc., but useful in chronic nephritis, glycosuria, acute rheumatism, etc. It is rarely given in acute fevers, but Sambrschitsky tried it in small but frequent doses in some apparently hopeless cases of enteric fever with conspicuous and unexpected success.

Section V.—Pathological

Milk, one of the best culture media for pathogenic bacteria, may, if drunk raw, be the means of spreading disease.

It may be infected when secreted by a cow suffering from (*a*) a disease common to her and man; (*b*) proper to her but communicable to man; or [?] (*c*) a human disease to which she is in some degree susceptible; or healthy milk may be infected by the hands of the milkers or others, or through admixture of specifically polluted water, enteric fever through water, and scarlatina and diphtheria by personal agency. No others have been proved to be thus propagated, though the presence of large numbers of intestinal, pyogenic, or simply saprophytic bacteria can scarcely fail to produce ill, albeit non-specific effects. The only communicable disease common to man and cattle is tuberculosis, but it surpasses in importance all others, the human and bovine forms being one and the same, and the alleged differences in the appearance of tubercular pleurisy and the grapes or pearl disease easily explained by the peculiarities of the tissues. Tuberculosis in each is closely associated with overcrowding and defective ventilation, being practically unknown among the hardy cattle roaming without shelter throughout the year on prairie, steppe, or moor, but prevailing among dairy cows according to the length of time during which they are shut up in cow-houses, and most so among the tender Jerseys and cows of all breeds in urban dairies.

An enormous proportion of milch cows are more or less affected, but there is no evidence of their milk being infective unless the mammary glands are involved. With the improved social and sanitary conditions of the masses in towns, the better ventilation of workshops, etc., there has been during the last thirty years a notable reduction in the mortality from every form of tuberculosis, except the mesenteric disease in infants, which has greatly increased, apparently *pari passu* with the increased employment of cow's milk, to which one must ascribe a wholly preventable sacrifice of no fewer than 10,000 lives per annum in England and Wales, lives that might be saved by the simple expedient of boiling all milk for children.

Of bovine diseases foot-and-mouth alone is indisputably communicable to man by the consumption of the unboiled milk of affected animals without change of character, the use of such milk being followed after an incubation of four or five days by febrile disturbance, and eczema of the hands, feet, and mouth, and in infants a severe and often fatal pneumonia. Garget, a specific mammitis, produces aphthous stomatitis in infants, and may cause eczema in the hands of the milkers. There is no evidence as to the effect of cattle plague, pleuro-pneumonia, or anthrax in the milk, doubtless because the diseases themselves are so severe and deadly that the affected animals are never milked, but destroyed without delay.

Whether human diseases can be imparted to the cow and retransferred to man through their milk is still *sub judice*, but from the history of the outbreak of a peculiar disease in Panter's dairy at Hendon in the year 1885, it appears that such is the case with scarlatina. Introduced by a cow bought in the market it attacked nearly every animal in three large sheds, a considerable interval elapsing between the invasions of the second and third. Epidemics of scarlatina, beginning among the customers of the Hendon dairy, broke out in Marylebone, and, after an interval corresponding with the invasion of the last shed, in Hampstead, where the milk from that was separately sent. The symptoms in the cows were fever, difficult deglutition, and an erythematous and vesicular eruption, with desquamation and falling of the hair, while in a post-mortem examination of one Dr. Klein found nephritis, and in the urine streptococci resembling those of scarlatina. That the symptoms should differ in some respects from those seen in man is not more than one should expect; for instance, in the cat diphtheria always involves the lungs, whereas in the horse there are no lesions whatever, though the production of antitoxin proves the unchanged nature of the disease. The fact of milk being infected from external sources, and being thus a passive vehicle for the spread of scarlatina and enteric fever, is proved by the evidence of numerous well-established outbreaks.

Legal Considerations.—Sec. 4 of the Infectious Diseases Prevention Act, and sec. 71 of the Public Health (Lond.) Act, empower the medical officer of health, when satisfied that "dangerous infectious disease has been caused by milk from a particular dairy, to obtain from a magistrate an order prohibiting the sale of the milk *within the district*," when there is nothing to hinder its sale elsewhere, and as a matter of fact the condemned, or rather the inculpated milk, is usually sent to London to be sold as "accommodation milk" to retailers, when it may be the cause of many outbreaks, and scattered cases of disease that cannot be explained by local investigation.

SECTION VI.—ADULTERATION

Whatever may have been in the past, the only adulteration now practised is dilution with water or with separated milk. The former involves a reduction of the solids not fat as well as of the fat, and as they are far the less variable it is, unless very small, more easily detected than the latter, which if not carried to the extent of reducing the fat below the permissible percentage, cannot be proved to the satisfaction of the Court. The so-called standard fixed by the Society of Public Analysts, fat 2·5 per cent, other solids 8·5 per cent, is inexcusably low, representing not a "standard," but an irreducible minimum, and certainly encouraging, indeed practically legalising the watering of all milks of average or superior quality "to the prejudice of the purchaser," who does not obtain an article "of the substance, nature, or quality demanded."

Limits and Variations in Normal Milks.—Richmond found the average of 200,000 samples—water 87·10, fat 3·90, S.N.F. 8·80. The maximum and minimum F. 12·52 and 1·04, S.N.F. 10·6 and 4·9, but many of these may have been watered, since S.N.F. under 8 is strong presumptive evidence of dilution. Among 6462 normal milks from different breeds the fat was above 3 per cent in 6221, above 4 per cent in 4335, and above 5 in 1540. Bell found the fat to average over 5 per cent in Jerseys and Guernseys, and under 3 per cent in Sussex, Devon, Dutch, and shorthorns. The S.N.F. under 9 per cent in these and Kerrys, but the last-named had over 4 per cent of fat. From November to March all solids are highest, from May to August lowest; from February to April the fat falls rapidly, and in September and October the total solids are rising. The morning milk is richer than the evening, and Monday's milk is poorer, probably from neglect in feeding on Sunday. In 2293 the S.N.F. were under 8 per cent in 2 only. Boussangault found in six partial withdrawals of the milk of a single cow the fat to rise from 1·70 to 4·02, the other solids remaining practically constant, indeed the very last or "strippings" may yield 10 per cent of fat and be indistinguishable from cream, while the first or "foremilk" may have less than 1 per cent.

Preservatives.—It is much to be desired that the retailing of milk were wholly in the hands of substantial firms or companies, to the extinction of the petty dealer, for the former, whose daily send-out may be reckoned by thousands of gallons, can always keep their supplies considerably above the demand, putting the surplus nightly through the separator for turning it into the more lucrative form of butter, whereas to the keeper of a small shop a few gallons left on hand would mean the loss of the day's profits. It is therefore treated with a preservative which will keep it apparently unchanged until the next day, when it is mixed with the morning's milk or sold over the counter to the poor. Boric acid or formalin are most used. But such preservation is imperfect and transient. Milk cannot be sterilised by chemicals in the small quantities that can be used, and it is doubtful whether such milk is much less unwholesome than it would have been if sour.

SECTION VII.—EXAMINATION

Much ingenuity has been expended to little purpose on devices for the ready determination of the quality of milk.

The "cremometer," a graduated cylinder showing the percentage of cream rising spontaneously in a given number of hours, though exhibited in most dairies, is scientifically worthless, since the rate of rising depends on many conditions, and even when complete is in no constant ratio to the amount of fat. The "lactoscope," on the principle of the photometer, aims at determining the fat in suspension by the thickness of the film required to produce the same degree of opacity as one of normal milk 2 mm. thick. It is fairly accurate, but is now seldom employed here. "Lactometers," or aräometers, purport to show the specific gravity, or rather the specific volume, which is the resultant of the opposing factors of the fat which tends to lower it below that of water, and of the other solids which raise it higher; the latter being always in excess, dilution with water lowers the specific gravity about 3° for each 10 per cent added at the temperature of 60° F.; but the original specific gravity of the given sample must be known; and since abstraction of the fat raises it, poor milk having a higher, and skimmed milk the highest, specific gravity, it would be easy so to adjust the skimming and the watering that the specific gravity of the doubly impoverished milk should be the same as it had when pure. Quevenne and others have endeavoured to improve the lactometer by the addition of lateral scales intended to indicate the degree of dilution of normal and of skimmed milk, but they are quite untrustworthy for practical purposes. Useless as is the information afforded by the lactometer alone, the specific gravity should always be noted, since, taken in conjunction with the estimation of the total solids and fat, the reaction, etc., it may render valuable assistance in determining the nature of the impoverishment or the causes of the anomalous composition. The specific gravity of normal milk of individual cows ranges between 1·028 and 1·0397; that of the mixed milk of a herd, 1·030 and 1·035, or, as it is often expressed, from 30° to 35°, the average being 1·032. That of skimmed milk is 1·034 to 1·038; and of the fat, 0·93. Fleischmann, Hehner, Richmond, and others, have devised formulæ for determining the fat from the total solids and specific gravity. Taking T to represent the total solids, F the fat, D the specific gravity, and G the lactometer degrees (*i.e.* the excess of the specific gravity over 1000), the formulæ assume with the aid of empirical constants various degrees of complexity, but Richmond has simplified them down to $T=\frac{G}{4}+\frac{6F}{5}$, and to save calculation he has constructed a slide rule, known as the milk scale. (See for a mathematical discussion of the whole subject Richmond's *Dairy Chemistry*.)

Estimation of Total Solids.—Evaporation of a small quantity of milk in a platinum dish over a water bath. When 5 grams were taken three hours (Wanklyn) were found insufficient, and longer periods (*Soc. Pub. Anal.*) involve browning and decomposition. Vieth and Richmond substituting 1 gram spread over a large surface obtain by evaporation a perfectly white residue with higher and yet constant results. Richmond has designed a water oven that seems perfect.

Estimation of Fat.—The methods employed are gravimetric, volumetric, and indirect. The last, already mentioned, were originally suggested by Fleischmann on account of the time and skill demanded by the gravimetric; but some of the volumetric are so rapid and accurate as to render the indirect methods superfluous, and the gravimetric necessary only when extreme exactness is required. Many of these, some of which had enjoyed official sanction, have been proved untrustworthy and been condemned by all analysts (except those of Somerset House). Adams' is undoubtedly the best of the gravimetric methods, and the Werner-Schmid of the volumetric; but Gerber's, which requires less technical skill, is sufficiently accurate for all routine examinations, and takes less time than even Schmid's. Adams' process has been exhaustively studied by chemists in England and in Germany, and Schleicher and Schüll have prepared a "fat-free" paper which, unlike the blotting-paper originally used by Adams, yields only inappreciable amounts of extracts soluble in ether. Vieth fully confirmed Adams' observation that in filtering milk the paper retains the whole of the fat, the other solids passing through in the filtrate, or if the milk be wholly absorbed by the paper the fat remains on the surface. For the details of the process, the weighing, etc., recourse must be had to technical works; suffice it here to say that samples (5 grams) of the milk are run from a pipette into strips of fat-free or exhausted papers large enough to absorb the whole, which are dried and weighed with strict precautions, rolled and transferred to a Soxhlet's apparatus, where the fat is extracted by ether. The results are extraordinarily accurate, but the process occupies an entire working day, and Schmid's method, with Stoke's improved pipette, gives in skilled hands identical results in less than half an hour. Ten (or five) c.c. of the milk with the same of hydrochloric acid are mixed and boiled in the special tube, then cooled to 16° C. under the tap, 30 (or 15) c.c. of ether added, and the tubes, after shaking, set aside for the etherial solution of the fat to rise, when a third or other aliquot part is carefully pipetted off without disturbing the flocculent layer of albumin between it and the watery portion, evaporated at 100° C., and the fat determined by weighing with the usual precautions. The special feature and merit of Schmid's process is the conversion of the casein into an acid albumin, and the consequent absence of any coagulation or drying which in other methods impedes the extraction of the fat. In the Leffmann-Beam and the Gerber methods the milk is mixed with prescribed quantities of amylic alcohol (and hydrochloric acid) and sulphuric acid in specially graduated tubes or flasks, which are rotated in a centrifugaliser worked by hand for a few minutes, when the fat, separating as a clear semi-fluid column, is read off on the scale, the marks on which represent parts and tenths of parts per cent in the 15 c.c. used, fractions of tenths being guessed by the eye. This method is not sufficiently accurate to be, like Adams' and Schmid's, relied on in prosecutions; but the results, approximating theirs within 0·1 per cent, are quite good enough for routine and preliminary examinations.

The estimation of the sugar, casein, albumin, and salts is never required in dairy or legal practice, unless perhaps in corroboration of opinions formed as to anomalous findings.

Bacteriological Examination.—Milk in the udder of a healthy animal is sterile, and when drawn with great care may have fewer than 100 bacteria in the c.c., but as sold the numbers range from 30,000 to 30,000,000, the average in the London shops being 3,000,000 to 4,000,000. For the purpose of enumeration it must be diluted 1 : 0·1, 0·01, and 0·001 c.c. to 10 c.c. of water, so as to obtain a numerable dilution. For the quantitative examination a sample of the milk is centrifugalised in a stoppered tube, the cream and the sediment collected separately, and the "skimmed milk" thrown away. The sediment and the cream are spread on clean cover slips, dried, flamed, and immersed for at least five minutes in alcohol, in ether to remove the fat, and in alcohol again, and after washing in water stained by the Ziehl-Neelson method for the detection of tubercle bacilli.

Milk always contains some leucocytes, but when twenty or thirty are visible in the field of a $\frac{1}{6}$ objective it is suspicious, and the sediment of some samples actually consists of pus, even when tubercle bacilli may not be seen. In such and in other doubtful cases inoculations should be made on guinea pigs. The Klebs-Löffler bacillus may be found by taking advantage of its rapid growth on inspissated blood serum. That of enteric fever is so soon crowded out by others that it can rarely be demonstrated, but a large number of B. coli, especially in milk that has been fraudulently watered, is suspicious. B. coli is evidence of the presence of fæcal matter, the cows'; or of that of man derived from polluted water. The bacteria of diphtheria, scarlatina, and enteric fever are also of extrinsic origin, but besides the B. tuberculosis numerous pus organisms and streptococci of mammitis and other diseases of the udders are intrinsic, and may be pathogenic at any rate to infants, as are those of foot and mouth disease.[1]

Chemical Tests for Preservatives.—Boric and salicylic acids are detected by the usual laboratory tests, those for the latter being really tests for phenol, but that as such is an impossible adulteration. For the qualitative determination of boric and salicylic acids reference should be made to Richmond's work.

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[1] The best instructions for the bacteriological examination of milk will be found in a paper by Mr. Walter Pakes in *Public Health* for March 1900.

Formaldehyd is detected by the red colour following the addition of 1-2 c.c. of a 0·1 per cent watery solution of phloroglucin, with a few drops of liq. pot. or sod. to 8-10 c.c. of milk. It is not a quantitative test, since the deepest coloration is produced when the formaldehyd is present in the proportion of 0·00004, and a rose tint can be recognised in 0·00004 dilutions, but little, if any, in 10-30 per cent solutions. Since, however, the quantity of formaldehyd in milk is always very small, this anomaly does not detract from the value of the test. (For other tests, see Richmond, *op. cit.*)

SECTION VIII.—CONTROL

It is much to be desired that the county councils should, as in Italy, appoint a veterinary surgeon, co-ordinate with the county medical officer of health, and exercise through these officers, assisted by those of the local authorities, the general control of dairy farms. A few of the great dairy companies do this to a certain extent with the farms with which they deal, but these form a small minority, and the rest are under no supervision whatever, except in some of southern counties of Scotland. Such inspection should extend to the health of the cows, the conditions of the sheds, cow-houses, and yards, the water-supply, and the cleanliness and arrangements of the dairies as treated in sections I. and V.

So vast an undertaking as the total elimination of tuberculosis, Utopian as it might appear, would be practicable by means of legislative and organised action, as it has been successfully carried out by individual owners of herds in Denmark and in this country following the procedure laid down by Professor Bang of Copenhagen. Tuberculin, an extract from sterilised cultures of the bacillus, though not curative or preventive of the disease, provides an almost unerring means of diagnosing its presence long before any physical signs appear. Injected into a healthy animal it produces no effect, but in all but the very earliest stages of tuberculosis it gives rise to a febrile disturbance extending over several days and with a characteristic curve, provided the operation be performed and the effects observed by experts. Bang directs that the entire herd be tested simultaneously, those that react removed to other sheds at a distance, and no communication permitted between the attendants on the healthy and the affected animals. The latter should be at once fattened for the butcher unless already in calf, when they may be allowed to calve once, since the instances of congenital transmission are infinitely rare, but the calves must, if not killed, be transferred immediately to the healthy herd. The stalls of the healthy cattle should have been thoroughly disinfected, and any newly purchased cows kept in quarantine while being tested. Since some incipient cases may have failed to react, the testing should be repeated at intervals of six months, until, on the second, or at the latest the third testing, none are found to respond. Under any circumstances should tubercle bacilli be found in the mixed milk of a herd, the affected animal or animals should be traced by sampling each cow's milk in succession, after having restricted the field by the examination of that of groups.

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Plato says truly that "the purpose of education is to give to the body and the soul all the beauty and all the perfection of which they are capable." If for "soul" we read "mind" we see that the old philosopher was aware that true education consists in training the body as well as the mind, so that we may have *mens sana in corpore sano.* The body and brain are dependent on one another, and, as we shall shortly show, it is necessary that both be well nourished; if they are not mental activity will be lessened.

According to the psychologist states of action of mind can be analysed into three elements, viz. ideation, feeling, and volition, or knowing, feeling, and willing. Herbert Spencer goes further, and says that the various degrees of intelligence are known as instinct, memory, reason, emotion, and will. According to the physiologist states of action of mind consist in some change—molecular, chemical, or vital—in the nerve cells of the brain. To those of us who are physicians the physiological definition appeals, and in what we have to say regarding the education of the mind, physiology rather than psychology will be appealed to.

The nervous system, as Maudsley says, consists of primary or ideational centres, secondary or sensory centres, tertiary or reflex action centres, and, fourthly, organic nervous centres which belong to the sympathetic nervous system. The primary are constituted by the gray matter of the convolutions of the hemispheres; the secondary by the collections of gray matter which are situated between the decussation of the pyramids and the floors of the lateral ventricles; the tertiary by the gray matter of the spinal cord; while the organic nervous centres consist of a set of ganglionic bodies which are distributed over the viscera, and are connected together and with the spinal centres by interganglionic cords. Each of these centres is subordinate to those above them and superordinate to those below.

It is this nervous system which we have to educate. In order to do this efficiently it is necessary that the nerve centres should be well supplied with blood, and that the quality of it should be good. If the quantity of blood supplied is deficient fainting or loss of cerebral action ensues, and consequently there is a decreased nervous discharge. Chronic feebleness of the heart's action will produce the same result. Again, if the proper quantity of blood is sufficient, local anæmia, as the result of an embolism produces paralysis. On the other hand, if the nerve-centres have an unusual amount of arterial blood, rapid response to disturbance ensues, and extraordinary amounts of force shown in nervous changes or muscular action, or both, are the result. As regards the peripheral nervous system the same law holds good. If there is a reduced quantity of blood, however produced, any part which is exposed to cold will have decreased sensibility, and the muscles will respond sluggishly to the motor impulses. This is frequently seen in cases of idiocy and imbecility. If, again, there is slowing or stoppage of the local current of blood, the nerves cannot perform their function and become incapacitated, as is seen in the blindness which occurs when the central artery of the retina is blocked. Excess of blood, on the other hand, causes unusual excitability of the peripheral nerves, so that a slight touch produces a start of the whole body.

It is equally necessary that the quality of the blood supplied should be good. We know that if a person imbibes alcohol unusual amounts of nerve force take place; and we also know that the blood must contain a sufficient quantity of oxygen in order that the normal degree of nervous activity may be produced. It is requisite that certain substances, such as carbonic acid and urea, should not be present. If the amount of carbonic acid exhaled is deficient, lethargy ensues, and peripheral excitations do not result in the usual responses. If exhalation is arrested completely insensibility is the result, and arrest of all functions of the body is complete. In the same way an accumulation in the blood of urea or nitrogenous products causes a decrease and final stoppage of nervous action. If the kidneys fail in their function, or if the waste nitrogenous material does not escape from the body, but is reabsorbed, coma, and finally death, ensues. It is necessary, therefore, that the blood which supplies the nervous centres should be sufficient in quantity and excellent in quality if they are to maintain the proper amount of nervous action. So much stress is laid on the influence of the neuron just now, that there is a danger that the circulation of the blood in the brain by which the neuron is nourished may be overlooked. Professor Donaldson says (1) "no amount of cultivation will give good results where the nerve cells are few and ill-nourished, but careful culture can do much where there are those with strong inherent impulses towards development."

In order that the nervous system may be properly educated it is important that this should commence when the child is young. Education should begin at the age of five, and be continued until the child is eighteen years old. As one writer puts it, "From birth to seventeen years of age is the period of growth and development; from seventeen to maturity at twenty-four is the period of development without growth." Hallech says that he has demonstrated to his own satisfaction that young cells are more amenable to training than any other matter of which he has knowledge.

There is no doubt that the nerve cells can be developed in three ways—(1) The sensory parts of the brain undergo change by afferent currents from the different senses; (2) The motor tracts are altered by being engaged in the initation of new muscular acts, and the repetition of those which have been already learnt; (3) The association functions of the brain are enlarged by being brought into use. That the first proposition is true is shown by the fact that in persons who have had deficient special senses there is an imperfect development of the areas which have had to do with those senses. The case of Laura Bridgman is an illustration of this point. When three years old she had scarlet fever, and as a result became deaf, and a few years afterwards blind. Professor Donaldson examined her brain, and says (1)—"It is interesting to notice that those parts of the cortex, which, according to the current view, were to be associated with the defective senses, were also particularly thin. The cause of this thinness was found to be due, at least in part, to the small size of the nerve cells there present. Not only were the large and medium-sized nerve cells smaller, but the impressson made on the observer was that they were also less numerous than in the normal cortex." He goes on to say—"For the cells continually appearing in the developing cortex no other source is known than the nuclei or granules found there in its earliest stages. Elements intermediate between these granules and the fully developed cells are always found, even in mature brains, and therefore it is inferred that the latter are derived from the former. The appearances there lead also to the conclusions that many elements stop short of complete development, and that the number which might develop in any given case is far beyond the number that actually does so, and that the characteristic appearance of the cortex in the various localities depends on the expansion of dissimilar layers of the primitive granules." It is necessary to remember that the senses act on the brain in such a manner as to cause a change in it, and as a result the nerve cells become more developed. As regards the motor area, modifications of it change the correlated muscular reaction in health in a normal way and in disease in an abnormal manner. With respect to the fibres of association, their development is accompanied by a marked change in the cortex, and it is known as the child grows older the number of these fibres becomes increased. In fact, without these fibres we could have no memory, association of ideas, and motor action. Dr. Flatau says (2)—"The main function of the association fibres is probably psychical. They appear the most fitted to form the anatomical basis for the association processes of perception, thought, and will."

From what has been observed, it appears necessary that the sensory tract of the brain must be well developed, because all thought and imagination, if rigidly analysed, will be found to rest on this sensorial area. There is no doubt that the education of the young should begin by the education of his special senses, and it seems probable that as the sensory cells develop by exercise, the association fibres leading from them to other parts of the brain will increase in number. All authorities who have studied the subject lay stress on the importance of training the senses. Comenius says (3)—"First the senses should be exercised, then the memory, then the understanding, and lastly the judgment." Canon Daniel says—"Children are not sufficiently required to use their senses. They are allowed to observe by deputy. They look at nature through the spectacles of books, and through the eyes of the teacher, but do not observe for themselves." Dr. Seguin, to whom belongs the honour of having created the true method of teaching idiots and imbeciles, in his books strongly impresses upon his readers that the education of the senses must precede the education of the mind, and defines his method as (4) "the adaptation of the principles of physiology, through physiological means and instruments, to the development of the dynamic, perceptive, reflective, and spontaneous functions of youth." According to modern views the education of the senses does educate the mind, for it is impossible to educate any special sense without altering or developing the nerve cells of the brain which control that sense. The senses are educated by means of different concrete objects, for all development of knowledge is from the concrete to the abstract. The system of kindergarten teaching depends upon developing knowledge from the child's playful activity, and making use of the common objects by which he is surrounded, objects and actions being arranged in a connected manner. The kindergarten gifts serve not only to satisfy the child's desire for play, but also as influences for knowledge as to form, colour, material, number, and names. By this system the faculty of observation is exercised to distinguish likeness from difference; and the powers of thought are exercised in arranging sticks or strips of paper, and in imitating the form of models, and making variations of these, opportunities being made use of by the teacher to impart information as to the qualities and properties of objects in daily use. In this way is originated the foundations of the knowledge of arithmetic and mathematics, reading, grammar, literature, and the physical sciences. Later on the child imitates outlines and forms and written language, and so gradually learns drawing, painting, and history. The local surroundings give rise to experiences by means of which geography, natural history, and botany may be taught. Our mental ideas begin by being object-ideas, and pass by stages into subject-ideas. Frœbel's maxim was "Learn by doing." The child should handle the objects for himself, and describe what he sees; and when nothing further can be discovered, the teacher should make suggestions and give information, the child afterwards proving the truth of the suggestions and information which have been imparted to him. Dr. Karl Lange says that anyone who has seen children properly taught "knows how far their energetic learning is from a simple, passive reception, and that not the teacher, but they themselves have the most to perform." The word education of itself shows that the child is not simply a vessel which has to be filled, but an organism which has to be supplied with digestible and easily assimilable food.

In order to train the senses objects must be made use of to educate the sense of smell, taste, touch, hearing, and sight. To train the olfactory sense, cinnamon, cloves, pepper, caraway, assafœtida, flowers and perfumes will be found useful, and the gustatory sense can be trained by fruits and food of various kinds. As regards the sense of touch, smooth substances such as silk, and rough substances such as wood, will be found of use, and so will the surfaces of various fruits. With respect to auditory training, life in the country is desirable, as indeed it is in cultivating the olfactory and visual senses. The songs of birds, the cawing of crows, the mooing of cows, etc. may be brought into play to develop the auditory tract of the brain. As to the visual sense, the objects that appeal to it are very numerous, for we must remember that most objects appeal to sight, and only a small number comparatively to hearing, taste, or smell. Wild flowers, garden flowers, the colour and shape of birds and fruits, animals, etc. will all help to educate the visual sense. For the training of all these senses, with the exception of that of sight, the child should be blindfolded, and then asked to name the objects that he touches, hears, tastes, or smells.

It is not only necessary to educate the special sense centres by presenting to them various objects, but in order to make the modification of them more distinct and permanent, images of these objects must be recalled. Ribot (5) says—"If, with closed eyes, we keep for a length of time an image of very lively colours before the imagination, and then opening the eyes suddenly we fix them upon a white surface, we see thereon for an instant the image contemplated in imagination, but in the complementary colour. This fact, as is observed by Wundt, from whom we borrow it, proves that the nerve-action is the same in the two cases—in the sense perception and in the memory." It is by the recalling of images that the memory is trained. Of course when images are recalled there is some change in the brain cells, probably in their molecular arrangement, as when the senses were stimulated, but not so intense. In order then that the brain may obtain permanent, and so a lasting memory, it will be necessary to recall the images as often as possible. The more often we think of a thing the more firmly is it retained in the memory. As Comenius (3) says, "*Repetitio memoriae pater et mater est.*" In connection with this fact it must be remembered that from the tenth to the fourteenth year memory is stronger than at any other period of life.

As regards attention, it is quite certain that if this faculty is not developed no improvement in the child's mind can take place. There are two kinds of it, the reflex or involuntary and the voluntary. When the activity is called forth by an external stimulus, such as the slamming of a door or a flash of lightning, it is termed reflex or involuntary; but when the activity is commenced by the mind itself it is called voluntary. In the latter case we are conscious of an effort, and more severe drafts are made upon the brain than in involuntary attention. If we are listening for an approaching footstep, the voluntary attention so centred makes the brain cells in the auditory centres more sensitive to sound, and the same may be said with reference to the other centres. This preparation of the mind to receive a certain form of experience is by psychologists called pre-adjustment of attention.

Mental work, however, uses up the energy in nerve cells and causes fatigue. There is no doubt of this, as it has been proved to be true by the experiments of Hodge and others. Long hours in school or in mental work do not favour the development at any rate of memory. Ribot (5) says—"Fatigue in every shape is fatal to memory. The impressions received under such conditions are not fixed, and the reproduction of them is very laborious and often impossible. Now, fatigue is regarded as a state wherein, owing to the over-activity of an organ, the nutrition suffers and halts. When the normal conditions are restored memory comes back again." It is therefore necessary that subjects should be frequently changed, for in the same way that change of position in a limb will enable it to do more work, so a change of subject, which involves a different direction being given to the attention, enables additional mental effort to be made. Not only, however, should the subjects be frequently changed, but more play and manual work, and less continuous mental work, would probably give better results. Mr. Edwin Chadwick, who has studied the subject, is of opinion that children from seven to eight years of age should not work more than from 2½ to 3 hours a day; those from eight to ten years old, from 3 to 3½ hours; from ten to twelve about 4 hours; from twelve to fifteen between 5 and 6 hours; and from fifteen to eighteen never more than 8 hours, sufficient time being given for recreation out of these times. In elementary schools he says that children who only attend as half-timers progress quite as much as those who attend full time.

As regards motor training, it must be remembered that the products of sensations affect motor centres, and action is the result. When sensation is excited movement ensues; this fact alone shows that sensory training is the cause of motor development. If motor reactions do not follow sensations primarily or in the form of memory images, we know we have to deal with an imperfectly developed brain. A man seeing a lamp-post, for example, and avoiding it, is an instance of a sensation taking a motor action and influencing the muscles. This may be called a primary motor reaction, but reactions also occur when excited by memory images, as when, for instance, we imagine a very high mountain, movements in the muscles controlling the eyes will occur. Kulpe (6) says—"Movements are everywhere important. It is perhaps not too much to say that a voluntary recollection never takes place without their assistance. When we think of intense cold our body is thrown into tremulous movement, as in shivering; when we imagine an extent of space our eyes move as they would in surveying it; when we recall a rhythm we mark its rise and fall with hand or foot." Now, as motion is the only thing which produces anything, it is very important that we should have motor ideas. The dreamers in life who are always going to do something and never accomplish it get by degrees motor paralysis. Motor action should be cultivated and be directed to definite ends. As boys and girls grow older ideal suggestions have more force, so that, as Wundt (7) says, "the memory image of a movement is apt at once to arouse the movement itself." A study of motor reactions and their resulting habituations is evidence that education should chiefly consist in doing. To tell a child how to do a thing is of little use; the pupil must himself perform the necessary actions, for that is the only way to get the desired result. It should be remembered by teachers and parents, as well as medical men, that children can control the muscles of the limbs sometime before those of the fingers, and it is of no use to expect a child to be able to write or draw until he can control the muscles which put the fingers into action. Motor tracts require as careful training as sensory tracts, and they should be developed as early as possible, while they are still in a plastic condition. Drill is especially important in developing the muscles, and manual training in enabling the child to control the fine movements of the fingers. Modifications take place in the motor area of the brain, and correlated muscular reaction ensues.

As regards the fibres of association, we have already mentioned that their development is of the utmost importance. Without them perception, memory, and thought could not exist. We cannot form a complete image of an orange, for example, until we have tasted it, smelt it, seen it, and touched it. The different stimuli which pass into the gustatory, visual, etc. centres of the brain must be connected together by means of the association fibres in order to make our knowledge of an object as complete as possible. If our sensations were incapable of being connected memory would be impossible, for in developing this faculty it is necessary to proceed by association from one idea to another. So with reference to thought, it is necessary to have all our knowledge associated, so that clear ideas may result. In mind-blindness the patient sees, but cannot interpret the impressions, and the memory of visual images is lost. This effect has been produced in dogs by extirpation of the occipital lobe, and by destruction of the first temporal convolution in the same animals mind-deafness is produced. In this last affection, although the auditory apparatus is unimpaired, the power of recognising words and terms is lost. It is inferred, therefore, that in man mind-blindness and mind-deafness are due to diseases of the occipital and first temporal convolutions. This then proves how necessary it is that all our senses should be in good order, so that the association of ideas shall be clear and well defined. These senses must be well associated too, or we could never recall the various sense aspects of anything. Vulpius, who made a careful study of the tangential fibres, the fibres of association in the brain, found that they increased considerably between the ages of sixteen months and thirty-three years of age, and during this period the brain becomes increased in size and weight. It is therefore clear that every effort must be made to develop these fibres, for when new brain cells become associated a physical foundation is originated and a new idea is brought into existence.

While pursuing the intellectual education of the child it is important that the moral training should not be neglected. To a great extent this is in the hands of the parents; and when the children are still young, truthfulness, honour, and uprightness should be strictly inculcated. Character is then formed, and if it is not done then it will be difficult afterwards. Many parents leave their children too much in the hands of their nurses and servants, and if the moral character of these is deficient, the child is bound to suffer. He begins by doing wrong, and if not checked the evil develops, and when he goes to school grosser faults appear, and finally some glaring vice takes place and expulsion is the result. The older a boy is, and in like manner with the girl, the less chance he has, if his moral training has been neglected, of learning self-control and self-respect, and the result may be a dishonourable existence. True happiness depends upon a well-ordered life, and only those whose moral training has been strictly attended to can expect the approbation of their fellow-men.

Having treated of the way in which the education of the mind should be conducted, it only remains to show by what means certain classes of children should be instructed and treated.

Weak-minded children, especially, require that their senses should be educated, and that all teaching should be on the concrete system, as they are not capable, at least at first, of comprehending abstract ideas. It is unnecessary to say more of this class of children, as they have already been described under the heading of "Mental Deficiency." In many cases mental dulness is due to the presence of adenoids, and if the child is noticed to sleep with his mouth open, these growths should be looked for, and if found they should be removed.

As regards *nervous children*, great care in their education is necessary. Such children sleep badly, grind their teeth, talk in their sleep, have night-terrors, are too tall for their age, and grow thin, though they have no actual disease. In the Report on the Scientific Study of the Mental and Physical Conditions of Childhood no less than 3522, or 3·5 per cent of the 100,000 children seen were noted to be of low nutrition. These nervous children often become irritable and passionate, and suffer from headache. If they are not properly taught, or if they have to undergo too much study, they easily become fatigued, exhausted, and suffer from irritability. If they stand upright with their hands stretched out on a level with the shoulder, the palms downwards and the fingers stretched out, they exhibit what Dr. Warner calls "the nervous hand,"—that is, the wrist is slightly flexed, the knuckles are moderately extended back beyond the straight line, the finger-joints being slightly bent. The thumb is extended backwards and sometimes drawn away from the fingers. In addition to this, the fingers slightly twich, and there is lordosis. It is essential that the signs of fatigue should be known, because, if they are not recognised and attended to, fatigue passes on into exhaustion. Fatigue is accompanied by loss of force, both mental and physical, and action is less easily excited through the senses. Irregular movements may occur; the fingers may twitch when the boy holds the pen, and he is not only inclined to fidget, but is irritable and peevish. Loss of force is shown by fulness under the eyes and sometimes corrugation of the eyebrows. If the hands are held out in front of the body, as mentioned above, the thumb will be noticed to be drooped. A fatigued child is slow in his movements and in his mental action. The cure for fatigue is change of occupation. If the above signs are not noticed or attended to, fatigue passes on into exhaustion. In this condition the facial muscles are wanting in tone; there is not only fulness under the eyes, but a lengthening of the face owing to the muscles becoming relaxed. The ordinary stimuli do not bring forth the ordinary expressions, and sighing and yawning commonly occur. The tone of the voice is different from the normal, and speech is slow in character. Instead of co-ordination on the mental and motor functions, there is inco-ordination and disorderly brain action, and if work is still persisted in chorea or epilepsy will be the result. When exhaustion occurs work must be interrupted, and abundance of fresh air, sunlight, and rest from work must be prescribed. Occasionally there is a breakdown at the time of the second dentition. When this happens there must be relief from study, substitution of amusement for books, exercise in the open air, and removal from town to country.

Hysterical children, especially girls, must never be overworked. In many cases there is a hereditary predisposition to this affection, and then the power of the will being weakened, the emotions are unduly strengthened, and irritability of the nervous system is the result. In fact, those children who are predisposed to this affection are frequently peevish and irritable[1]; but convulsive attacks do not appear until puberty occurs. In many of these cases the special senses are unnaturally acute, while in others, especially after severe seizures, the senses of smell, taste, and sound are lost, and the field of vision is restricted. In the first class of cases sensorial training should be in abeyance; but in the second class every means of arousing these senses, such as have been previously described, should be exercised. Children of this kind should be trained to be unselfish, but as this cannot be done at home as the mother is herself often irritable and capricious, at one time harsh, at another indulgent, while the father has no time to look after his children, removal from home is necessary, and the child should be placed under the care of a governess or nurse who is known to be firm and judicious. Self-control is difficult to teach, and can only be accomplished by the exercise of this faculty by the instructor. The education of the child must not be interrupted, but should be well directed, and amusement should be practised in moderation. If children of this class are overworked chorea will be the result. We have had many girls suffering from chorea under our care who at the same time were hysterical.

Epileptic children, if of normal intellect and the epileptic attacks are not severe, should be educated in ordinary schools; but care must be taken not to overwork them. The signs of an approaching fit are irritability, twitching of the muscles, mental dulness, and a complaint of headache; if these are noticed the lessons should be reduced. The slight form of epilepsy (*petit mal*) may cause the child to be inattentive to his lessons, so that when there is a likelihood that he suffers from this complaint punishment must on no account be inflicted. Children suffering from severe epilepsy, and who retain their normal intellect, require to be educated in epileptic homes in the country. Dr. Alexander, who has had considerable experience in their treatment, says (8) "that at home the usual parental discipline that moulds the civilised child is wanting or fitful in its exercise, and the epileptic tends to become a young savage, with all the delights of a savage in cruelty and oppression." The Elementary Education (Defective and Epileptic Children) Act, 1899, allows school authorities to establish schools, certified by the Education Department, for epileptic children, and to contribute towards the maintenance of certified schools; but the schools should be in the country. The schools have to provide for the board, lodging, and medical treatment of the children as well as their education. Two homes for epileptic children, one for boys and one for girls, have been built at the Chalfont Colony for epileptics, but the Act above mentioned has an unwise provision, allowing only fifteen epileptic children to be accommodated in one building, or sixty in four such buildings, and as provision was made for twenty-four in each of the Chalfont Homes, they cannot at present be used for the purpose for which they were built. As regards their education, a "Minute of the Committee of Council on Education," dated February 26, 1900, has been issued, and makes arrangements for instruction in reading, writing, and arithmetic, singing and recitation, object lessons, drawing, needlework for girls, physical exercises, and manual training. This is a good arrangement, as physical as well as mental instruction has been provided, and in the case of the younger children, the usual kindergarten training, "learning by doing" has to be taught. Older boys are to be instructed in various trades and gardening and farm work, and older girls in cookery, laundry work, practical housewifery, besides the needle-work already mentioned. For boys and girls in the higher classes of life, special provision should be made (see also "Epilepsy" and "Epileptic Colonies," vol. iii.).

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[1] See also "Hysteria in Children," vol. v.

Children morally imbecile are a very difficult class with which to deal. Intellectually they are sharp and clever; but their moral character has never been developed, and they thieve, tell lies, are full of cunning, and sometimes are criminal in their tendencies. They promise to behave better if they are remonstrated with, but these promises are like pie-crust easily broken, and a slight cause produces another outbreak. Usually these cases possess good manual skill, but unfortunately use it for bad purposes. Dr. Jules Morel, who has given a good deal of attention to these cases, is of opinion that they should be confined in buildings specially set apart for them, so that they cannot infect other children with their evil tendencies. There is no doubt that this is a good plan, for if they are not kept under control, they will end their lives in prison, which is certainly not the place for them. In these institutions they should be made to work at some trade in order to keep them as much as possible out of mischief.

Children suffering from moral perversion, of not such severe character as the class just prescribed, should be sent to a special school. These children are often thieves and liars, but they can be reclaimed if properly treated. They require careful management and individual character training. For such boys I can recommend the Clayesmore School, Enfield, Middlesex. In this school the headmaster says, "the highest stress is placed upon the personal insight and study of each boy, with a view to individual character, formation and strengthening, or, in other words, 'character' and hence 'power' is considered first and knowledge 'second.'" This school contains classical and modern sides, and the instruction is of the public-school character, except that in this school every boy is properly taught; whereas in some of the public schools the clever boys are pushed on, while the duller ones have in great measure to shift for themselves. Great attention is paid in the Clayesmore school to manual work, which helps to stimulate the powers of resource and self-reliance.

Scrofulous children and children of consumptive parents must on no account be pushed on with their school work. On the contrary, they should be kept back; if this course is not pursued the result will be meningitis. They require plenty of exercise in the open air, sunlight, good nourishing food, a large amount of sleep, and the administration of cod-liver oil and maltine.

If healthy action of the brain is encouraged, there will be less liability to nervousness, headache, and epilepsy. For this purpose it is necessary that there should be plenty of fresh air in the schoolroom. It has been observed that where schoolrooms are insufficiently ventilated the pupils soon become fatigued and restless. The diet should consist not only of meat and vegetables, but of a good supply of sugar and starch, as these substances are necessary for the formation of heat in the body. As boys and girls are both growing beings, plenty of sleep is essential. Boys who do not have sufficient sleep suffer from lowered vitality; and girls not only suffer from want of vigour, but the establishment of the new functions at puberty is interfered with. Dr. Dukes says the amount of sleep required by boys under ten years of age is eleven hours; for boys under thirteen years of age, ten and a half hours; and for boys above thirteen, eight and a half or nine hours; and the same remarks apply to girls. The number of hours per day at which children of different ages should work has already been mentioned. Finally, the school should be situated, if possible, on gravel soil; on a clay soil there is likely to be a humid atmosphere, which will be wholly unsuitable for children of rheumatic, consumptive, gouty, and neuralgic constitutions.

LITERATURE.—1. DONALDSON. *The Growth of the Brain.*—2. FLATAU. *Atlas of the Human Brain.*—3. HOLMAN. *Introduction to Education.*—4. SEGUIN. *On Idiocy.*—5. RIBOT. *Diseases of Memory.*—6. KULPE. *Outlines of Psychology.*—7. WUNDT. *Lectures on Human and Animal Psychology.*—8. ALEXANDER. *Treatment of Epilepsy.*

Mineral Waters.—This name is given to those natural waters which are used either internally or in the form of baths in the treatment of disease, their action being due in some cases to contained salts or gases, in others to their temperature.

In dealing with the action of mineral waters three factors have to be taken into account:—

(1) *The Pharmaco-dynamic.*—In drinking cures by the agency of solutions of salts or gases certain operations are accomplished in the system, and, in addition, gases are absorbed from baths containing such constituents.

(2) *The Hydro-therapeutic.*—The actual water swallowed is of definite therapeutic value; and the heat of the water bathed in, and the use of douches, frictions, and various other hydropathic processes, has to be taken into account.

(3) *The Climatic, Dietetic, and Psychical.*—Rest, change of air and scene, relief from the usual occupations, and a carefully-regulated diet and regimen have no small influence in producing favourable results.

Mineral baths act in various ways:—

(*a*) By thermal effects.

(*b*) By pressure and mechanical effects.

(*c*) By salts and gases contained in the waters.

The hydro-therapeutic effects and methods are fully described in the articles on "Hydropathy" and "Balneology."

The general action of baths is also dealt with in the article on "Balneology."

It is proposed here to write more especially of the specific actions of the salts and gases contained in the various natural waters, to give a classified list of the chief waters, and also some guidance as to selection in disease.

It is now generally admitted that the skin will not absorb water nor contained salts; therefore the various saline constituents of the mineral waters can only act when used in baths by influencing the nerves or blood-vessels of the skin.

Gases, on the other hand, are readily absorbed and taken up by the skin, and so play an important part in the therapeutic action of mineral baths.

Classification is difficult, and to all the various systems advocated there is some objection. On the whole, however, the chemical classification seems the most direct and simple, the difficulty, however, being that some of the waters might be placed in two or three of the classes on account of their several constituents:—

I. Simple thermal waters (often called indifferent thermal waters):
  (*a*) Containing nitrogen.
II. Muriated saline waters:
  (*a*) With carbonic acid gas.
  (*b*) Without carbonic acid gas.
  (*c*) With bromine and iodine.
III. Alkaline waters:
  (*a*) Simple alkaline.
  (*b*) Muriated alkaline.
IV. Sulphated saline waters:
  (*a*) Simple sulphated (bitter waters).
  (*b*) Alkaline sulphated.
V. Chalybeate waters.
VI. Sulphur waters:
  (*a*) Simple sulphur.
  (*b*) Muriated sulphur.
VII. Calcareous and earthy waters.

I. *Simple Thermal Waters.*—These waters are characterised by their elevated temperature, ranging from 80° to 150° F., by the small quantity of contained salts, and by their softness and transparency.

Action.—Has been thought to be due simply to the effects of warm or hot water taken internally or in the form of baths, mainly as follows:—

Drinking.—The stomach washed out; tissue changes augmented and effete matters removed; secretion of bile, urine, etc., increased.

Bathing.—Softening of skin, acceleration of its circulation, calming of nervous and circulatory systems, absorption of exudations.

(*a*) *Nitrogen-charged Thermal Waters.*—Many of the simple thermal waters contain nitrogen gas in large quantity, and it has been noted that such waters have a notable influence on gout and rheumatism—Buxton, Wildbad, and Gastein in particular.

Armstrong of Buxton has recently published the results of over 10,000 observations. His conclusions are as follows:—

(1) That the quantity of urine passed and the excretion of uric acid and urea are largely increased both by drinking and by bathing in the nitrogen water.

(2) That it is more efficacious when bathed in than when taken internally as regards uric acid excretion.

(3) That with drinking, the diuresis is greater than when used as a bath.

(4) That any deviation from the normal temperature either by heating or cooling interferes with its efficacy.

(5) That while alteration of temperature would not be likely to diminish the therapeutic properties of the salts, they would, on the other hand, greatly interfere with the contained gas.

The result of this investigation may supply an explanation of the marked specific action of some of the so-called simple thermal waters. Kionka increased the excretion of uric acid in birds 40 to 50 per cent by giving small doses of powdered egg-shells (calcium bicarbonate), and Van Noorden has given this remedy with success in chronic gout. As many of the indifferent thermal waters contain lime salts, Kionka's results may have some bearing upon their value as a drinking cure. Certainly the very definite therapeutic effects of such waters as those of Bath, Buxton, Wildbad, Gastein, Schlangenbad, Ragatz, and other similar spas, in gout and rheumatism cannot be put down to the effects of simple hot water alone.

Indications.—Gout, rheumatism, rheumatoid arthritis, sciatica, lumbago, diseases of nervous system (early stages), neuritis, neuralgia, neurasthenia, after effects of injuries to and thickening of joints, intestinal troubles, gastric and uterine affections, pelvic exudations.

Chief Thermal Waters

Name.	Country.	Elevation, Feet.	Temperature of Springs.
Bath	England	100	104° to 120°
Buxton	England	1000	82°
Wildbad	Germany	1410	91° to 104°
Schlangenbad	Germany	900	82° to 90°
Badenweiler	Germany	1400	70°
Gastein	Austria	3310	78° to 121°
Teplitz	Austria	730	83° to 114°
Plombières	France	1300	77° to 155°
Bagnères de Bigorre	France	1750	72° to 120°
Ragatz	Switzerland	1700	98°
Lœche-les-Bains	Switzerland	4600	102° to 122°
Bormio	Italy	4300	90° to 104°

II. *Muriated Saline Waters.*—Common salt is the main ingredient in these waters. Taken internally it stimulates the secreting power of the stomach and intestines, hastens tissue change, and increases circulation, especially through the portal system. Combination with carbonic acid gas much increases its action both on the stomach and intestines.

The saline baths undoubtedly stimulate the peripheral nerve-endings and the capillary-vessels, and have a distinct effect upon various internal organs, especially the heart, through the central nervous system, which action is much enhanced by the presence of carbonic acid gas.

Muriated Salines with Bromine and Iodine.—This combination, present in the waters of Woodhall in England, and Kreuznach in Germany, is much used in uterine troubles, fibroids, and the various pelvic exudations. Baths and vaginal injections are used, and the water is also drank.

Indications.—Chronic rheumatism, gout and arthritis, scrofulous complaints, anæmia, gastric and hepatic congestion, uterine troubles and pelvic exudations, uterine fibroids, obesity.

Nauheim has a special reputation in cases of cardiac disease. The forms of heart affection in which this treatment is indicated are cardiac dilatation, mitral disease with failing compensation, the alcoholic and post-influenzal heart, some cardiac neuroses and other functional affections, and early cases of fatty heart.

In conjunction with the baths resisted exercises are given.

Llangammarch water contains barium in medicinal quantities, and is also useful in cardiac cases.

Chief Muriated Saline Waters

Name.	Country.	Elevation, Feet.	Temperature of Springs.
Containing Carbonic Acid Gas			
Homburg	Germany	600	Cold
Kissingen	Germany	600	Cold
Nauheim	Germany	400	82° to 95°
Wiesbaden	Germany	380	100° to 156°
Baden-Baden	Germany	650	124° to 150°
Without Carbonic Acid Gas			
Droitwich	England	200	Cold
Nantwich	England	150	Cold
Bridge of Allan	Scotland	40	
Leamington	England	200	Cold
Ashby de la Zouche	England	400	62° F.
Cheltenham	England	150	Cold
Llangammarch	Wales	600	Cold
Châtelguyon	France	1300	550° to 110°
Ischl	Austria	1500	
Ischia	Italy	...	145°
Panticosa	Spain	5600	78° to 88°
Containing Bromine and Iodine			
Woodhall	England	37	Cold
Kreuznach	Germany	340	Cold
Bourbonne-les-Bains	France	900	119° to 180°
Bex	Switzerland	1400	

III. *Alkaline Waters—*

(*a*) Simple alkaline.

(*b*) Muriated alkaline.

The main constituents of these waters are carbonate of soda and carbonic acid gas in class (*a*)—with the addition of chloride of sodium in class (*b*). Oxidation and tissue change are greatly influenced; the secretion of bile and saliva is increased; and the waters act as diuretics, antacids, and general solvents.

Indications. — Dyspepsia with gastric acidity, hepatic congestion, sluggish portal circulation, gall-stones, diabetes (hepatic form). Uric acid diathesis—gout, chronic catarrhal affections of digestive and respiratory organs, obesity.

Chief Simple Alkaline Waters

Name.	Country.	Elevation, Feet.	Temperature of Springs.
Vichy	France	736	Hot and Cold
Mont Dore	France	3421	112°
Vals	France	...	Cold
Evian	France	1240	Cold
Tarasp	Switzerland	3890	
Neuenahr	Germany	760	72° to 104
Muriated Alkaline Waters			
Ems	Germany	300	80° to 120°
Royat	France	1480	430° to 95°
La Bourboule	France	2780	140°

The waters of Mont Dore, La Bourboule, and Neuenahr contain arsenic in medicinal quantities.

IV. *Sulphated Waters—*

(*a*) Simple sulphated (bitter waters).
(*b*) Alkaline sulphated.

The former contain the sulphates of soda and magnesia, the latter the sulphate and carbonate of soda and chloride of sodium. The bitter waters stimulate the mucous membrane of the alimentary canal; their action is modified by the addition of the soda carbonate and sod. chloride.

Indications. — Constipation with portal congestion, some forms of dyspepsia, gastric catarrh, gall-stones, gout, hepatic congestion, diabetes, and obesity.

Chief Bitter Waters

Name.	Country.	
Pullna	Austria	Used for bottling only.
Hunyadi Janos	Hungary	
Rubinat	Spain	
Friedrichshall	Germany	

Alkaline Sulphated Waters

Name.	Country.	Elevation, Feet.	Temperature of Springs.
Carlsbad	Austria	1214	122° to 170°
Marienbad	Austria	1912	cold
Tarasp	Switzerland	4500	cold
Franzensbad[1]	Austria	1900	cold

V. *Chalybeate Waters.*—*Action.*— Improve general nutrition, increase oxidation and production of heat, and encourage formations of red blood corpuscles. The action of the baths is due most probably to the contained carbonic acid gas.

Indications.—Anæmia, chlorosis, neuralgia, sterility, general debility.

Chief Chalybeate Springs

Name.	Country.	Elevation, Feet.
Tunbridge Wells	England	420°
Harrogate	England	200° to 600°
Shanklin	England	
Flitwick	England	
Strathpeffer	Scotland	
Trefriw	Wales	
Schwalbach	Germany	950°
Spa	Belgium	1000°
Pyrmont	Germany	
St. Moritz	Switzerland	5800°
Levico[2]	Austria	1600°

VI. *Sulphated Waters—*

(*a*) Simple sulphur.
(*b*) Muriated sulphur.

These waters rely for their effects either upon the sulphides of sodium, potassium, and calcium, or upon the presence of sulphuretted hydrogen, the muriated group containing sod. chloride in addition.

Action.—Small as are the quantities of contained sulphur, there is undoubtedly a distinct action upon the stomach, intestines, and liver, which is enhanced by the addition of the sodium chloride. There is no doubt that the sulphuretted hydrogen is absorbed by the skin when baths are taken.

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[1] Franzensbad is celebrated for its mud-baths.
[2] The Levico water contains arsenic.

Indications.—Disorders of liver and stomach, skin diseases, rheumatism, gout, mercurial and lead poisoning, syphilis (in conjunction with mercurial inunction or injection).

Chief Sulphur Waters (Simple)

Name.	Country.	Elevation, Feet.	Temperature of Springs.
Moffat	Scotland	400	
Strathpeffer	Scotland	200	
Lisdoonvarna	Iceland	430	
Askern	England		
Gilsland	England		
Baden	Switzerland	1230	118°
Bagnères de Luchon	France	2000	
Aix-le-Bains	France	850	112° to 114°
Challes	France	880	Cold
Helouan	Egypt	200	90° to 110°
Muriated			
Harrogate	England	260 to 600	Cold
Llandrindrod	Wales	700	Cold
Aachan	Germany	530	113° to 133°
Acqui	Italy	450	102° to 158°
Cauterets	France	3200	55° to 145°
Uriage	France	1350	Cold

Aachan makes a speciality of the treatment of syphilis—mercurial inunction and injection being excellently given there.

VII. *Earthy and Calcareous Waters.*—Carbonate and sulphate of lime and carbonate of magnesia are the most important constituents. These waters often contain much carbonic acid gas.

Action.—Calc. carbonate has a soothing effect upon the lining of the digestive canal, and is a good antacid; the sulphate is slightly astringent, and the action of carbonic acid has been dealt with previously. The lime has been said to assist the bone-forming process.

The researches of Kionka and Von Noorden, previously mentioned, as to the action of calc. bicarbonate on the excretion of uric acid, possibly have some bearing on the action of these waters.

Indications.—Digestive troubles with tendency to acidity, irritation of the gastro-intestinal mucous membrane, diarrhœa, rickets, chronic catarrh of bladder, gravel—kidney and bladder calculi.

Chief Calcareous Waters

Name.	Country.	Elevation, Feet.	Temperature of Springs.
Contrexeville	France	1150	Cold
Vittel	France	1200	Cold
Wildungen	Germany	980	Cold
Lippspringe	Germany	450	70°
Lucca	Italy	390	70° to 125°
Hamman R'Irha	Algiers	...	133°

Contrexeville, in particular, has a considerable reputation in bladder troubles and in kidney and bladder calculi. The water is drank in exceedingly large doses, and gravel and calculi are frequently passed during the course. This is generally considered to be due to the mechanical action of the large quantities of fluid taken.

The mineral waters of India, America, New Zealand, Japan, Russia, Turkey, and Greece are mentioned in the article on "Balneology."

Mirror-Writing.—The term mirror-writing, Ger. *Spiegelschrift* has been applied to that form of writing which is executed from right to left, with the letters so arranged that when reflected in a mirror they look like ordinary writing.

True mirror-writing is written with the left hand. It has been found that some patients always write in the mirror fashion when asked to write with the left hand; and some cases (as, for instance, that recorded by Bernard) do not appear to be aware of the fact that the writing is peculiar. Bernard's patient wrote letters to her friends in mirror fashion and was surprised she did not receive answers from them.

I have seen several cases who wrote in this way and did not appear to think the fact at all uncommon. They simply took it for granted that this was the proper way to write with the left hand.

The condition has been looked upon by most clinical observers as an interesting and curious phenomenon, but one having little or no clinical or pathological significance. It had been noticed by various observers to have been exhibited by patients suffering from diseases of the nervous system, as, for instance, in hemiplegia (Poore and Elder), in hysteria (Savage), in locomotor ataxy (Bernard), in idiots and imbeciles (Ireland). From an investigation which I carried out a few years ago I found, however, that mirror-writing in a more or less perfect form was exhibited by a certain percentage of people in perfect health.

The results of my investigation I append here in tabular form :—

Results of Tests of Writing with the Left Hand

	Total Number.	Female.	Male.	Ordinary Writers.			Mirror-Writers.			Percentage of.		
				Total.	Female.	Male.	Total.	Female.	Male.	Mirror-Writers.	Female ditto.	Male ditto.
Over 15 years of age .	154	95	59	138	81	57	16	14	2	10·39	14·73	3·39
Under 15 years of age	297	242	55	290	237	53	7	5	2	2·35	2·06	3·63
Total .	451	337	114	428	318	110	23	19	4	5·1	5·63	3·5

These figures brought out very remarkable results. The total number tested was 451 and the percentage of mirror-writers was 5·1. There were 337 females and 114 males. The percentage of mirror-writers among the females was 5·63 and amongst the males 3·5. Of the 154 over fifteen years of age 10·39 were found to be mirror-writers, whilst of the 297 under fifteen years of age only 2·35 were mirror-writers. Of the 95 females over fifteen years of age 14·73 were mirror-writers, whilst of 242 under fifteen years of age only 2·06 wrote in the mirror fashion. Of 59 males over fifteen years of age 3·39 were mirror-writers, whilst of 55 under fifteen years of age 3·63 wrote in the mirror-fashion.

These figures undoubtedly showed that mirror-writing with the left hand is not such a rare condition as had been supposed. I believe, however, that it is exhibited by even a greater proportion of patients suffering from some forms of cerebral disease than these figures relating to the healthy subject bring out.

I have seen it frequently in hemiplegia, and Ireland records some interesting cases in imbeciles and children of weak minds. One was a paralytic imbecile girl between eleven and twelve years of age; another, an imbecile girl of fourteen; another, a congenital imbecile of twelve; and another, a boy of thirteen of moderate intelligence. These all wrote with their left hands and in the mirror fashion. Two left-handed idiot boys formed pot-hooks from right to left.

Ireland also cites a case of *Buchwald*, where the patient, a man of forty-five years of age, suffering from hemiplegia and aphasia learned to write with his left hand in the mirror-fashion. This patient, although shown how his writing was reversed, could not be induced to write in the proper way. Even after many attempts to copy he always reverted to the mirror method of writing. Some of my cases of hemiplegia presistently wrote in the mirror-fashion, even after having the fact of its being reversed pointed out to them, and they did so in a ready and fluent manner.

Mills records "that the left-handed show a physiological tendency to mirror-writing." Of a class of sixty boys and girls who tried to write their names with their left hands, two boys and three girls wrote in mirror-writing, and all of these were found to be left-handed. Out of another set of 134 children six were left-handed, and three of these were mirror-writers. One of Leonardo du Vinci's manuscripts is an example of mirror-writing, and it has been supposed that this singular style was adopted to preserve the work from superficial readers. But another reason is suggested: a priest who visited Leonardo during the last years of his life has recorded the fact that he had paralysis of the right hand, and as he was unable to use his right hand it may be that he learned to write with his left and became a mirror-writer.

How can mirror-writing be accounted for? Although statistics on the subject have not been collected, I believe it is much more common in certain cerebral diseases than is supposed. During the past few years I have been in the habit of testing the cases of paralysis under my care, and I have been much struck with the frequency with which I found the tendency to write in the mirror-fashion. Whilst I have found mirror-writing exhibited by patients suffering from hemiplegia due to lesion in the internal capsule, I have not come across a single case of mirror-writing in a patient with hemiplegia due to a lesion in the cortex involving the motor centres for the hand. Indeed, my experience has so far confirmed the theoretical conclusion I arrived at a few years ago, viz. that where a patient is paralysed on the right side, and shows mirror-writing when he attempts to write with the left hand, one is justified in concluding that the lesion producing the hemiplegia is not in the cortex, but in the pyramidal fibres below the level of the cortex, as in the internal capsule. This may, therefore, be a diagnostic symptom of no small importance. The abscence of mirror-writing, however, is of no importance from a diagnostic point of view, although its presence, I believe, is so important.

The theory on which this conclusion is based I discussed a few years ago in my work on aphasia; but I may summarise it shortly here. The movements which produce mirror-writing with the left hand I believe to be primarily guided from the left cerebral cortex, and only secondarily from the right cerebral cortex. The motor impulses for mirror-writing start in the cells in the left cerebral cortex, which are usually used for the guiding of the movements of the right hand. These cells are probably connected with corresponding cells in the right cerebral cortex, which cells guide or co-ordinate the movements of the left hand. If we take it that the cells in the right cortex can and do act along with the corresponding cells in the left cortex, then the writing which would be produced by the right cortex would not be like ordinary writing, but like mirror-writing; because, when one carefully studies mirror-writing, it is seen that not all the movements producing the writing are reversed. The movements producing lines from above downwards or antero-posteriorly are the same movements, and require the same muscles to perform them on the two sides, whether the writing is the usual writing or mirror-writing; but it is quite different in the lines from right to left. The movements which produce the lines from left to right, when the right hand is used, are similar movements to those which produce the lines from right to left when the left hand is used, and *vice versa*. The same muscles are called into action in each case, viz. the homologous muscles. Abduction or centrifugal motion of the right hand has its corresponding movement in abduction or centrifugal motion of the left hand. The corresponding set of muscles on the two sides is called into action, and we may conclude that the corresponding set of cells in the cortex of the two sides is called into action in the initiating of these movements.

We know also that some muscles in the body, such as the vocal cords, are completely bilaterally represented in the cerebral cortex, so that either cortex can innervate both cords. Some muscles as those of the face, tongue, lips, etc., are partially bilaterally represented in the cerebral cortex so that lesion of the fibres from one cortex produces paresis and not paralysis of one side of the face—the opposite cortex being able to innervate the muscles to some extent. What is to be supposed in connection with mirror-writing is a slight degree of this bilateral representation of the movements of the hands and fingers in the cerebral cortex. There is some evidence to show that in all probability this is the case. It is well known that it is easier to perform movements with both hands when homologous muscles in each hand are brought into action at the same time, than when heterologous muscles are brought into action. One sees this very distinctly in the familiar example of trying to twirl the thumbs in different directions. How much more difficult it is to do so than to twirl them in the same direction. Many more examples might be taken to illustrate this point that the two sides of the brain have greater facility in acting together than acting against each other. This fact, I believe, explains mirror-writing. The left hand of most of us has to be educated to write just as the right hand—it is awkward at holding the pen, at drawing lines, etc., but by degrees it is educated to copy the outlines of letters and words. Given, however, a person with a well-educated left cortex, an expert writer, probably also with a brain having the two hemispheres specially well associated through the corpus callosum, having also the speech centres more active and initiating in the left hemisphere than in the right, and the tendency will be for the left cortical cells, which are so expert, to guide or influence the corresponding right cortical cells, which are so awkward at the guiding of movements for writing correctly. Such guiding as I have shown will necessarily result in the production of mirror-writing, and this tendency will be even greater where the cells in the left cerebral cortex have been cut off from the cells in the anterior cornu of the spinal cord, such as occurs in internal capsular lesions involving the pyramidal fibres. Hence the relative frequency of mirror-writing which, I believe, is shown by hemiplegic patients. There is one other argument in favour of the movements which produce mirror-writing being guided from the same centres as those producing ordinary right-hand writing. As I have elsewhere shown, and as I have frequently observed, the mirror-writing when seen in the mirror exactly resembles the same person's ordinary writing. There is no mistaking it; it is the same handwriting, showing that the two are produced from movements guided in the same way.

I can hardly believe that the right visual centres are the guiding centres, as some have supposed, because the natural tendency of the visual centres would be to trace the letters in the usual form. Indeed, in all probability the less the visual centres are actively used in writing the more chance there is of the person writing in the mirror-fashion. This is probably the explanation of the fact that there is a larger proportion of mirror-writers in those over fifteen years of age, and in expert writers, than in those who are not so expert, and only at the copying stage or learning to write.

LITERATURE.—BERNARD. *De l'aphasie*, p. 237.—POORE. On "Craft Palsies" in Clifford Allbutt's *Practice of Medicine*.—ELDER. *Aphasia and the Cerebral Speech Mechanism.*—MILLS. *The Nervous System and its Diseases.*—BASTIAN. *Aphasia and other Speech Defects.*—Ziemssen's *Cyclopædia.*—WYLLIE. *Disorders of Speech.*

Miscarriage. *See* ABORTION.

Mole: Molar Pregnancy.—The term mole, as applied to a mass formed within the uterus, is of extreme antiquity, and prolonged discussions as to its derivation and true application may be read in the works of the more ancient authors. For a complete account of the early literature of the subject the reader is referred to the *Historia Naturalis Molarum Uteri* (1), written by Lamzweerde in 1686. This author gravely discusses the possibility of the conception of moles after intercourse with the devil or with one of the lower animals; and as the result of various circumstances, such as taking a bath. The frontispiece to his work figures Justice seated above, scales in hand; below is a woman in bed, supported by her attendants, having brought forth several small rat-like animals, which are seen running about in the foreground. These are regarded by two physicians, one of whom maintains, as is indicated by the writing on a scroll in his hand, that the patient is *virgo intacta;* whilst the other, pointing to heaven, argues in the contrary sense. Little reference to the supernatural is found in later works, their authors, as a rule, dividing moles into two classes—the true and the false. True moles are those which result from a pregnancy which has run an abnormal course; false moles are masses formed in the uterus entirely apart from conception. The descriptions of substances recorded as false moles show that these included an infinite variety of pathological products—namely, new growths, such as sarcomata and carcinomata, fibro-myomata, polypi of the mucous and fibroid varieties, blood-clots, and bodies composed partly of laminated blood-clot and exfoliated layers of uterine mucosa. The term mole is not now applied to any of the above contents of the uterus, the advance of knowledge having gradually relegated each of them to its proper category under a more descriptive name. In accordance with the tendency to drop vague terms as soon as a deepening analysis renders it possible to do so, many authors have urged that the word "mole" should be excluded altogether from medical literature. But the term mole as applied to altered products of conception has been retained, and is, clinically, not without value, as it implies a definite and sufficiently accurate conception of the nature of certain cases, and can be used correctly long before a complete diagnosis can be arrived at.

Let us suppose, for instance, that a woman is known to have conceived, but that indications are present which show that her pregnancy is abnormal. There may have been some uterine hæmorrhage not followed by abortion. The breasts may have ceased to enlarge, and may have returned to their usual condition. Stirrage may be absent, though amenorrhœa and uterine enlargement may indicate that pregnancy has lasted five months or more. The size of the uterus may not correspond to the calculated duration of pregnancy. Under such circumstances the term "molar pregnancy" may, as a rule, be employed, until observation renders it possible to determine the condition more exactly. (See "Pregnancy, Pathology of, Ovum, and Decidua.").

If repeated examination shows that the uterus is increasing in size more quickly than usual, if repeated hæmorrhage occurs, and especially if the uterine tumour feels soft and boggy, the presence of vesicular degeneration of the chorion or hydatidiform mole will be suspected.

If, on the other hand, uterine enlargement continues very slowly, the other signs of pregnancy meanwhile disappearing, we may conclude that the ovum is dead, and that the increase in the size of the uterus is due to the escape of blood into it time after time. The blood extravasated on each occasion coagulates and forms a series of laminæ around the perished ovum, so that when the mass is at last expelled, it may be several months after the death of the fœtus, it is found to consist mainly of blood in varied stages of degeneration. Such a mass is known as a bloody mole or *mola cruenta*.

In other cases it may be observed that the enlarged uterus maintains its size almost exactly, neither growing nor lessening appreciably. Hæmorrhage in such cases is an uncommon symptom, though it is usually free when at last the uterus expels its contents. This is then found to consist of an ovum whose cavity is much reduced in size, and often contains no trace of a fœtus. Its walls, however, are much thickened, and are firm and fleshy in consistency. Section shows that blood has been effused into the space between the chorion and the decidua, and has there coagulated and become more or less organised (2). The condition is, strictly speaking, one of subchorionic hæmatoma, and the mass formed is known as a fleshy mole or *mola carnosa* (which see). Hart (3) has described a "fibrous mole," in which organization had proceeded further than usual, the mass being consequently more tough and fibrous. In cases of yet another class the uterus is found to decrease slowly in size for some time, although a dead ovum is retained within it. After weeks, or even months, a small shrunken ovum is expelled. In these cases hæmorrhage has played no part in the destruction of the ovum, which, after its death, loses bulk by absorption of its fluid elements; and as this loss of bulk is not replaced or exceeded by the effusion of blood into the uterine cavity, the uterus itself lessens in size, since it follows the decrease of the shrinking ovum. Such ova are often termed "blighted." It is clear that the masses known as "bloody mole," "fleshy mole," "fibrous mole," and "blighted ovum" are all simply the uterine content as observed in different varieties of "missed abortion" (which see). Their differences in structure depend mainly upon two factors—(1) the amount of blood effused into the cavity of the pregnant uterus; and (2) the length of time during which the ovum is retained in utero after its death. (See "Pregnancy, Pathology of, Ovum, and Decidua.")

Apart from the retention and alteration of complete ova, incomplete abortion may be followed by the formation within the uterus of a mass or mole composed of layers of blood-clot surrounding a more or less detached portion of placenta. Such a mass, if pediculated, is known as "placental polypus," and may so closely resemble a true polypus that its true nature cannot be discovered without microscopic examination.

Questions of medico-legal importance may arise in connection with any mass expelled from the uterus. In the first place, it may be important to determine whether or not such a mass is a product of conception. For this purpose sections must be made and submitted to careful microscopic examination. The discovery of chorionic villi is the only positive evidence that pregnancy has occurred, since the work of Eden (4) and others has thrown serious doubt upon the belief that the presence of decidual cells affords proof that conception has taken place. Secondly, question may arise as to the date of the conception to which the formation of the mole is due. For example, the case of *Kitson* v. *Playfair* arose concerning an abortion which was completed on 23rd February 1894. The mass then removed from the uterus was stated to contain fresh placental tissue left in utero after a recent abortion. This statement was considered to be libellous, and the mass was explained by the plaintiff as the result of conception at least eighteen months previously. The ovum was said to have perished in October 1892, when some hæmorrhage occurred, but to have been retained in utero sixteen months thereafter. The defence pled privilege and lost the case, which could doubtless have been won had justification been pled. For after placental tissue has been retained in utero for a few weeks, the chorionic villi and the blood in the intervillous spaces undergo changes which render them easily distinguishable from those of fresh placenta. To say exactly how long an ovum has remained dead in utero is impossible, because several factors are concerned in determining the alterations which occur; but the distinction between fairly fresh placenta and that which has been retained in utero for some weeks should present no difficulty.

Tubal Mole.—In ectopic pregnancy the ovum may die, and more or less blood may be effused into it just as in uterine gestation. The result is the same in each case; as if septic infection does not occur, and if the effusion of blood is not sufficient to cause rupture of the gestation sac, the blood within the sac becomes clotted, and forms a mole within the tube or other structure which contains the ovum. Many cases of this kind doubtless occur without being recognised. A considerable amount of absorption follows, and in some very well authenticated instances the only trace left by the condition has been slight thickening of the broad ligament involved. (See "Ectopic Gestation.")

LITERATURE.—1. *Historia Naturalis Molarum Uteri*, Joh. Bapt. de Lamzweerde, Lugd. Batav, 1686.—2. Fothergill. *Edin. Med. Journ.* March 1899, and *Brit. Med. Journ.* Jan. 1898.—3. Hart. *Trans. Obstet. Edin.* vol. xxiv.—4. Eden. *Trans. Obs. Socs. Lond.* 1897.

Mollities Ossium. *See* Osteo Malacria.

Molluscum Contagiosum. *See* SKIN, TUMOURS OF.

Morbus Cæruleus. *See* HEART, CONGENITAL MALFORMATIONS OF.

Morphinomania and Allied Drug Habits.

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THE term morphinomania, as coined by Charcot, or morphinism as used by Levinstein, signifies an uncontrollable craving for morphia by means of subcutaneous injection, which takes hold of its victim with a grip of terrible power, ever increasing its hold and dominion, and demoralising the mind, the senses, and the system of those who own its sway.

The first attempts at hypodermic medication were made by Mr. Rhynd of Dublin[1] in 1845, while to Mr. Wood in 1855 is due the popularisation of the method.

For a long time the vice of opium-eating, including smoking and drinking, has been known and recognised as one of the great social evils of Oriental countries. But even in England opium has had its victims, though not to such an extent as to obtrude themselves on society and be recognised as a great class of unfortunates. De Quincey maintains that in his time (1856) they were "a very numerous class indeed," and gives a long list of celebrities of the day known by him to indulge in the habit.

Is morphia, then, going to take the place of opium, and bring to us Western peoples the horrors we have been accustomed to associate with the smoking dens of the East?

It would appear that the use of morphia has already become a steadily-increasing habit. Hospitals have been opened specially for the treatment of morphia habitues. There is one in Berlin[2] organised by Levinstein, and one at Gratz in Styria with 300 patients. In Brooklyn[3] one has been opened for habitués of morphia, cocaine, and chloral.

Dr. Norman Kerr in his work on "Inebriety" says: "The result of my observation is that the habit of morphia injection is undoubtedly on the increase." According to Jouet and Zambaco the practice has become almost a matter of fashion amongst the ladies of Paris and Constantinople, and presents are made of pretty syringes, with silver and jewel-set cases, so that ladies can make reciprocal injections of morphine at any convenient opportunity. To show how little is thought of the habit abroad, a traveller relates how a lady in a railway carriage in the south of France "raised her skirt so as to expose the bare skin of her thigh immediately above the stocking, and injected a syringe full of morphia, giving her fellow-passengers, who listened with intense interest, a long account of the subjective symptoms that would follow."[4]

According to M. Foville's estimate, there were 40,000 morphinomaniacs in Paris in 1883. In 1893 there were, according to M. Dubut de Laforet 100,000.[5]

One of the popular preachers in Chicago lately stated to his audience that there were in that city 35,000 persons who habitually took morphia. He believes, however, that lately the number is diminishing rather than increasing since cycling became popular, for it has led many to seek, from fresh air and exercise, that relief from insomnia and worry which otherwise would have been looked for through the hypodermic syringe.[1]

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[1] Vide *Dublin Medical Press*, March 12, 1845, p. 167.

[2] *B. M. J.*, 1890, vol. ii. p. 812.

[3] *Ib.* 1891, vol. i. p. 1393.

[4] *Ib.* 1892, vol. i. p. 187.

[5] *Ib.* 1893, vol. i. 1026.

Morphia injection was introduced into Shanghai as a cure, forsooth, for opium smoking. From this it was introduced into Hong-Kong, and six months after there were twenty houses carrying on a systematic trade, each house with an average of fifty clients, who called regularly morning and evening for their injection. These injections were given by ignorant, unqualified persons at a charge of about one halfpenny, and the practice was growing with such fearful rapidity that happily the authorities had to take notice of it, and issued an ordinance making the practice illegal.[2] In 1895, we read that the consuls in China constantly draw attention to the continued habit of injecting morphia by unqualified persons at several ports. Those who sell morphia and give the injections make a profit of from 200 to 400 per cent. One victim said: "It is much cheaper than opium-smoking, and I get the same satisfaction out of it. I know of ten Chinese doctors, each of whom treats 50 to 100 men daily with this medicine."[3]

In 1896 it is reported that the practice of injecting morphia by unqualified persons having been checked at Hong-Kong, has spread to Singapore, and is becoming very prevalent on the mainland.[4]

It is quite evident, therefore, even allowing for some exaggeration in these statements, that morphinomania is increasing with terrible rapidity and spreading with fearful swiftness.

There is equally little doubt that it is upon the members of the medical profession that the greatest havoc is being wrought, as compared with any other class of the community. Obersteiner, speaking of the prevalence of morphinism among the profession in Austria, hints broadly that, in his view, there is poetical justice in the fact that this fatal habit should work most havoc among the class of men who, by carelessly prescribing the drug, and instructing in the use of the hypodermic syringe, have been mainly instrumental in disseminating it. Of Levinstein's 110 cases, 47 occurred in persons belonging to the medical profession or dependent on it: thus, 32 physicians, 8 wives of physicians, 1 son of a physician, 4 nurses, 1 midwife, and 1 student of medicine were among his patients. M. Lacassagne states that of 545 morphinomaniacs within his knowledge, 289 were doctors, or over 50 per cent. He says it is well known that several of the most distinguished men of the profession in Germany who have died in recent years were devotees to the fatal drug.[5]

Dr. Jules Rocard says that females and doctors are most addicted. Women delight in declaring how they indulge in the vice, and show with pride their ornamental syringes. Men take the greatest pains to hide their vice, so it is difficult to estimate the precise numbers, but he believes that doctors and those associated with them form half the total male victims.[6] Dr. M'Naughton Jones agrees that medical men form the largest number of cases.

The first introduction to the seductions of the drug can generally be traced to its administration by a medical man for the relief of pain, melancholia, or insomnia. This is where our responsibility arises, and where we should consider well before we grant that first introduction. It is questionable whether for melancholia and insomnia it should ever be given, especially by the hypodermic method, except as a last resort.

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[1] *B. M. J.*, 1895, vol. ii. p. 1371.

[2] *Ib.* 1893, vol. ii. pp. 803 and 1135.

[3] *Ib.* 1895, ii. p. 572.

[4] *Ib.* 1896, i. p. 1531.

[5] *Ib.* 1893, ii. p. 142.

[6] Cf. *Union Médicale*, 1894.

Some cases undoubtedly originate in other ways, but they are quite in the minority. A patient of Dr. Richardson told him that he took it first simply to see what it was like, and finding it pleasant continued it till he found he could not live without it. In another case related by Obersteiner, a physician could not believe in the ease and pleasure it gave to a patient suffering from cancer; he took one dose himself as an experiment, but it immediately awakened in him such a craving that he was never afterwards able to give it up. William Blair, author of *The Opium Habit*,[1] when reading De Quincey's *Confessions*, shut the book after having read "the Pleasures," and without reading "the Pains," he began deliberately to cultivate the habit, and soon learned the pains for himself with many a bitter regret! These may illustrate cases originating from *experiment* or curiosity, and doubtless many so arise. Some few many arise from *imitation*, as instanced by Dr. Foot, where "one could give no better reason for it than that a friend who lived in the house with him had recourse to it, and that he 'followed suit.'" At least one case has arisen in a downright *criminal* manner, viz.: where a husband induced his wife to take it, in order that he might get a divorce in the French courts.[2]

It is fortunate that every constitution does not bear morphia well, that on some it does not produce that intellectual excitement and psychical pleasure which creates the inappeasable hunger; that on others even small doses produce great depression, sickness of stomach, hallucinations, and horrible dreams. Also, that as with alcohol, the strength of each individual's self-control largely determines whether, having once tasted the sweets, he is able to firmly lay them aside again. But it is not a drug to be trifled with; it has helplessly bound great intellects as surely and as easily as it has enslaved the most frivolous pleasure seeker. So while still vaunting in the strength of our own self-control, we will yet wisely decline to put it to the test. Some few striking instances are on record, as if to cheer the fallen, but not to encourage the foolhardy, where victims have conquered through their own unaided strength. Dr. Blair[3] mentions the case of a man who used morphine for several years, and gave it up after sixty-five days' struggle; it was ten months, however, before he began to get a little sleep. De Quincey continued the use, or abuse, of opium for fifty-two years. Four times he broke himself off it, but only for a few months at a time, and then continued it again. Finally he gave it up for ever. In his own words: "I triumphed, but infer not, reader, from this word 'triumphed' a condition of joy and exultation; think of me as one, even when four months had passed, still agitated, writhing, throbbing, palpitating, shattered."

The quantity of morphia or opium daily taken by a habitué varies greatly, partly according to the length of time they have taken the drug, partly owing to individual susceptibility. Christison mentions that "450 drops of the best laudanum have been taken by a gentleman, unused to opium, without any other effect than some headache and constipation; and, what is even more singular, his son, aged six years, took 60 minims of muriate of morphia without any apparent ill effect." Another case is mentioned of a young man, who, reading of the visions produced by opium, and "yearning for the large excitement" took 60 grains at a dose, yet lived to tell the tale.[1] In certain diseases attended with pain enormous doses are tolerated; Dr. Walter Smith[2] mentions that in a case of chronic rheumatism 45 grs. of morphia have been given, and in another case of metritis with rectal fistula 24 grs. of the acetate of morphia were given in one day. He also quotes Fleming as mentioning a case in which 20 grs. of morphia were taken at a dose, and another case in which the daily quantum rose to the almost incredible amount of 462·9 grains of morphia. This, however, at last proved fatal. Dr. Braithwaite[3] cites a case in which 40 grs. of morphia were taken hypodermically in 24 hours. De Quincey confesses to 8000 minims of laudanum = 320 grains of opium, as his daily portion at one time of his life.

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[1] Harper and Bros. 1865.

[2] *B. M. J.*, 1891, i. p. 484.

[3] *Loc. cit.*

In a case reported by Dr. Stuart of New Zealand, the daily quantity injected for some months was 40 grains of the acetate of morphia.[4] A case is reported of a chemist who took 60 grains by hypodermic injection per diem.[5] Norman Kerr mentions the case of a female who drank one pint of laudanum daily, and swallowed 3 grains of solid opium at a single dose; also a case in which 20 grains of morphia were injected in a day in divided doses. In my own experience, one case took 12 grains of morphia hypodermically as his regular daily average; in another the regular dose was 15 grains. This was an American sailor, who from holding a high position had sunk to the level of an ordinary seaman through this vice. He sailed from San Francisco for Liverpool having provided himself with 600 grains of morphia, 2½ lbs. of "gum opium," and one pound of "ymshi" to open if his supply of morphia became exhausted.

He calculated that by using only 15 grains a day his stock would last out till he got to "Europe," leaving a little over in case of delay on the journey and until he got a fresh supply on this side. He explained that "ymshi" was the residue left in the pipe after smoking opium; this when rubbed up with water made a paste which he called "tinker," by the addition of more water he was able to inject this hypodermically, but it was difficult to manage properly and caused abscesses. "Ymshi" could be obtained plentifully in San Francisco, where there are many smoking dens, and was very cheap. Having mentioned this Yankee, I may say here that he added several new words to my vocabulary, *e.g.* he invariably spoke and wrote of the syringe as a "hypogun," and naturally then the injection was a "shot."

These large doses are of course arrived at by degrees, tolerance being gradually cultivated. At the same time it is astonishing that the drug can be so quickly got rid of. It is well known that it is rapidly eliminated by the kidneys; it has also been well established by Hitzig[6] that morphia is secreted by the stomach after hypodermic injection; and it is quite possible that some may, as Diedreich has pointed out, be converted into some substances which have the property of, to some extent, counteracting the toxic effects of the drug.

The next question to be considered is *diagnosis*. This only applies to cases in which the vice is concealed or unsuspected. In such cases it is, as Dr. Foot says, rather a question of *detection* than diagnosis. Not infrequently the cause of the patient's condition, in the early stages, is not for a moment suspected by his or her closest relatives or friends. It is most studiously concealed from the doctor, and guarded by the most vigorous falsehoods if the question is approached. A lady under Dr.

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[1] *N. American Review*, vol. xcv.

[2] *Commentary on the B.P.*

[3] *Med. Temperance Journal*, October 1887.

[4] Foot. *Dub. Journ. Med. Sci.* 1889.

[5] *B. M. J.*, 1890, i. p. 1470.

[6] *Berlin. klin. Woch.* 1892. No. 49.

Wilson's care exclaimed: "I call God to witness I neither now have, nor have had since I began the treatment, any preparation of opium or morphia whatever." Within ten minutes afterwards sixty quarter-grain pills of morphia were discovered secreted under her bolster.

The points to be noted are:—The face becomes pallid and pasty; anxiety, melancholy, and distrust are depicted in it; he wishes to be let alone, and so becomes unsociable and irritable; he is restless and shifty, and so loses the power of concentration and application to work. The appetite fails and actual gastric disturbance is frequent. He sleeps little, and that little is disturbed by unpleasant dreams. The pulse reveals nothing unless a tracing is taken; it is said to be normal during the period of satisfaction, but when the patient begins to feel cravings for the drug the pulse curve shows a flat top. If such a train of symptoms arouses suspicion, an examination of the urine[1] may now give some light. If morphia be found in it an excuse may be made to examine the patient stripped, then puncture-marks of the needle may be seen, especially if looked for on the extensor aspect of the left forearm or on the outer side of the right thigh and buttock. An abscess or small ulcer may be revealed, or even many such, with scars and stains of old ones. If one comes across a subcutaneous abscess on the limbs or trunk, and, seeing no immediate cause for it, find its contents fœtid—suspect morphia injection. But failing all such definite proofs, if the suspected person can be isolated away from his own home and closely watched so as to prevent him getting morphia, the craving will in due course appear, if the suspicions are correct, and so unmask the case. Even then no reliance can be placed on the statements of the patient as to either the amount or the frequency of the dose. Where there has been concealment the physician must be very certain of his ground before making a diagnosis of morphinism, seeing that it may involve the patient in a charge of gross untruthfulness. In many cases the diagnosis is not difficult. One patient I have seen, a gentleman by birth and education, was in the habit of carrying a piece of dirty newspaper in his pocket, and after each injection tore off a small piece, moistened it on his tongue, and applied it over the puncture. His arms were, in consequence, one mass of festering sores, scabs, pus, and newspaper, associated in sickening combination. Another patient, the Yankee before mentioned, had hundreds of scars, blotches, and sores scattered over his body. These were to be found on all parts of the arms from the wrists up, all over both legs from the ankles up, all over the trunk except a triangular area on the back, having the angles at the two shoulders and upper lumbar spine. In the groins the marks were particularly numerous, and he explained this by saying that he felt the effect more quickly there than anywhere else. The marks consisted of (1) bluish stains very similar in size and appearance to *tâches bleuatres*, in some parts these were as close together as the pits of smallpox, but I am at a loss to explain them unless the pigmentation was due to "ymshi;" besides these there were (2) an enormous number of pitted scars from small ulcers, together with (3) actual abscesses and ulcers in all stages, and (4) recent punctures also, appearing as small red dots.

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[1] Cf. Wynter Blyth, *Poisons: their Effects and Detection*, 1884, p. 292, etc. "The method adopted by Dragendorff to extract morphine from . . . urine . . . is to shake the liquid (acidified with a mineral acid) several times with amyl alcohol, which, on removal, separates urea and any bile acids. The liquid thus purified is then alkalised, and shaken up with amyl alcohol, and this amyl alcohol should contain any morphia that was present. On evaporation it may be pure enough to admit of identification, but if not, it may be redissolved and purified on the usual principles." [That is, dissolve in acidulated absolute alcohol, filter, evaporate the filtrate to dryness, dissolve in water, make alkaline, and extract again with amylic alcohol.]

TESTS (p. 280).—1. *Production of Morphine Hydrochloride.*—A solution of iodine dissolved in hydriodic acid gives even in extremely dilute solutions a precipitate. The crystals are dark red in colour, very definite in form; either free or collected in little radial groups.

2. *Iodic Acid Test.*—Dissolve in the least possible quantity of water, with the assistance of one or two drops of hydrochloric acid; mix with a very little starch paste, evaporate in porcelain dish, at a gentle heat to dryness. After cooling add to the dry residue a drop of a solution of 1 part of iodic acid in 15 parts of water: if $\frac{1}{20000}$ of a grain of morphine be present, a blue colour will be developed.

No ptomaine has been obtained which *both* liberates iodine from iodic acid *and* gives with iodised hydriodic acid a precipitate of the definite and identical form of morphine hydrochloride. Therefore both reactions above (but not necessarily one above) are proof of the presence of morphia.

The *effects* of the abuse of morphia are fairly well known in the abstract, but it may serve some useful purpose to consider them somewhat briefly in detail. At first, as a rule, the injections give genuine pleasure, but this soon becomes short lived, and after a regularly shortening interval is succeeded by a restlessness and craving which can only be appeased by another dose. Very soon, therefore, it is in order to allay this craving, "the terrible feeling," "the horrible sensation" as some victims express it, that they seek a fresh injection, and not for the pleasure that it imparts. To avoid a too rapid shortening of the interval, the strength of the dose has to be increased, and thus enormous doses are arrived at. The first effect of the dose is stimulating and exciting, brightening up the dormant faculties and awakening any energy the frame is capable of; but this stage is soon succeeded by a feeling of calmness, and then by dulness and stupor, soon to be arrested by a renewal of the restless craving. These latter stages being very much longer than the one of excitation, the general condition is one of fatuous listlessness; in fact, in the later stages of the habit, excitation may almost be said to be absent. Thus any of the business of life to be accomplished by the habitué must be attempted with the immediate aid of the needle—he is absolutely its slave. More and more the appetite becomes capricious until it is altogether lost, so that it is with difficulty he can get the stomach to take food or to retain it. Once the habit is fairly established there is no diminution of the secretions, and the bowels instead of being constipated, are regular or even relaxed. Sleep, however, is greatly interfered with; it becomes broken and fitful, and is disturbed by horrible dreams, so that he actually dreads the approach of nightfall. All these conditions tend, less rapidly than might be expected, but none the less surely, to bring about impairment of the nutritive processes, nerve exhaustion, enfeebled mental capacity, general wasting and emaciation, terminating certainly in insanity or death.

Besides these general ill-effects there is produced in men impotence and sterility, and in women amenorrhœa, sterility, and gradual atrophy of the genital organs.[1] As with almost all other inebriates, "love is transformed to hate, and he not unseldom loathes the sight of the devoted companion whom in his prenarcotic days he cherished with the tenderest devotion." "One man sold his wife for £12 and smoked the proceeds!"[2] Albuminuria is frequent and uræmia not uncommon. Huchard reports ten cases of albuminuria in morphinomania, ending in uræmia, and Löwenstein reports six or seven similar cases.[3] The wretchedness, misery, despair, and actual poverty induced by this absorbing vice not rarely leads the bond-servant to suicide, and this appears especially to be the case since cocaine came into use.[4] Many indeed seek to break their bondage by substituting another drug, such as cocaine or chloral, only to find themselves doubly bound by, if possible, a stronger and more deplorable vice. A minor evil which these unfortunates suffer is the formation of abscesses and ulcers at the site of puncture. This is almost invariable sooner or later, as the familiarity which breeds carelessness leads to the use of dirty, uncleansed needles. This indeed, in the case of the gentleman already mentioned, who used newspaper to cover the punctures, was the immediate cause of death, for though broken off his morphia he developed vague symptoms, with an erratic febrile temperature, ending in pulmonary complications, jaundice, and death. A post-mortem examination revealed a large fœtid abscess in the region of the tail of the pancreas. This had burrowed into the spleen, and opened into the colon. There were scores of small abscesses, varying in size from a pin's head to a large pea, scattered throughout the substance of the liver, and a similar condition in both lungs, together with large areas of consolidation.

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[1] Passower, *Obst. Soc. St. Petersburg*, 1893.

[2] Norman Kerr, *Inebriety*.

[3] *British Medical Journal*, 1890, vol. i. p. 1275.

[4] *Ibid.*, vol. ii. p. 812.

Another accident which frequently happens is the injection of the drug directly into a vein. The symptoms that follow this accident are striking and so alarming that it may not be out of place to give them here. In about thirty seconds an intense tingling sensation is experienced in the palms of the hands and soles of the feet, soon accompanied by profuse sweating and intense throbbing, first over the forehead, then over the whole head, with excruciating pain, as if the skull would burst asunder. The face becomes first deeply flushed, then cyanosed and swollen; the eyes fixed, staring, and bloodshot; the pupils are generally dilated as if over-stimulation had paralysed the ciliary nerve of the pupil sphincter. The action of the heart is then rapid, irregular, and feeble, and the breathing rapid and very shallow, as the least sigh seems to aggravate the intense cerebral pain. These symptoms last about 15 to 20 minutes, varying with the amount of the dose, then gradually pass off. Though the patient may have experienced the symptoms several times, and be quite aware of what has happened, they cause the greatest alarm to him and to any one who may be witness of them.

It is said by some that the morphinomaniac becomes not merely a bodily and mental wreck, but also a striking moral wreck. I believe that this statement is much too sweeping. It is granted that many, if not all, when the drug is withheld, will go almost any length to obtain it. Coleridge hired men to prevent him from getting opium, and dismissed them if they did their duty. He put himself under medical care to be cured of his vice, and pretended to be getting better, but all the time procured laudanum by stealth. There are plenty of instances of highly pious and honourable persons who, having become addicted to the drug, descended to lying, stealing, and cheating in order to obtain it; but if we look on that as part and parcel of their vice, we need not strip them of every shred of morality they ever had. It may not be said of all, but I believe it can be said of some: They were born gentlemen, they will die gentlemen, no matter to what depth of misfortune they have fallen.

The next and most important consideration is the *treatment*. Can these unfortunates be saved? They can, but the chances are against them. Foot says: "Emancipation from morphin-slavery is unattainable by voluntary effort." "Jaeckel is unaware of any successful case of self-treatment in morphinism, and does not advocate its being attempted, even in the case of medical men." Besides the case mentioned by Blair, I have only found one other case attested, viz. that of a chemist, who had taken up to 60 grains of morphia a day; he gave it up in October 1880, and in October 1890 was still free, never having taken it in the meantime.[1] It is obvious, therefore, we must assist them to do what they cannot do themselves. We must never forget the fiery ordeal, the terrible battle they have to fight before they can gain deliverance. The wretchedness and enfeeblement of mind and body will need unfailing sympathy, firmness, gentleness, and tact on the part both of physician and attendants to enable them to bear up and fight a victorious battle.

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[1] *British Medical Journal*, 1890, vol. i. p. 1470.

Of the methods there are two which may pass without consideration: the *deceptive*, which is puerile; the *substitution*, which is culpable. Cocaine is the drug which has been most used as a substitute for morphia. Erlenmeyer, who has had a very large experience, comes to the following conclusions: (1) That it does not stop the morphia craving; (2) that its effect is very transitory, lasting only from 12 to 25 minutes; (3) that cocaine is a real substitute for morphia, and not an antidote; (4) that it should not be given, as its effect is so temporary and its use dangerous, and very liable to develop a habit which is worse than morphinism. The other methods of *demorphinisation*, as Charcot calls it, consist in simply withholding the drug in one of three ways: (1) The abrupt or Levinstein's[1] method; (2) the *rapid* or Erlenmeyer's method; and (3) the *gradual* method.

Whether the habit has been of long or short duration, the withdrawal of the drug is followed by a train of symptoms classically known as *abstinenz symptome.* In some cases they are much more severe, and appear with greater rapidity than in others. Some persons endure them quietly with silent fortitude, others with abject and apathetic despair; but most patients exhibit constant restlessness, tramping excitedly up and down the room, wringing their hands, shouting, moaning, bewailing, entreating for the drug which alone can allay their sufferings. These sufferings are of various kinds, a peculiar uneasy sensation in the muscles, a "horrible sensation" as one patient called it, and could give no further description, though he had no mean command of language; also actual agonising pain in the bones and the neighbourhood of the joints, "as if he had been beaten with sticks or the bones broken." Again, intense pain of a gnawing character in the stomach, "as if rats were gnawing at his stomach," the very expression used by Mr. Addington and Dean Carlisle, as the patient pointed out to me afterwards when he read De Quincey. There is great irritability of the stomach, so that little or no food can be retained. Frequently there is polyuria, causing intense thirst, and commonly there is profuse diarrhœa, which may indeed become so excessive and exhausting as to threaten or terminate life. I have been forced to stop the treatment and give liberal doses of opium to check this dangerous symptom, but it was given in the form of pill, not by hypodermic injection. This stage of excitement is gradually replaced by a condition of profound exhaustion through which the sufferings still continue. Frequently hallucinations and delirium appear, with marked tremor, closely resembling the delirium tremens of alcoholism. Sleep is absolutely banished, and as food cannot be retained, the patient is in a few days reduced to extreme prostration, which may end fatally even if he has survived so long. Indeed, Dr. Levinstein, who advocated the abrupt withdrawal method, says "they most frequently become violent and suicidal, and out of a large number only 25 per cent recovered."[2] These symptoms are then so grave and alarming that the *abrupt* withdrawal method cannot be advocated except in rare instances, where the patient is strong and robust, where the habit has not become confirmed by long use, and the dose has not been excessive.

Erlenmeyer recognising the gravity of these *abstinenz symptome* advocated the *rapid* withdrawal method, cutting off the whole supply of morphia by largely diminishing doses in from six to twelve days. This method, however, though preferable to the abrupt method in that the danger is diminished, leaves much to be desired; the *abstinenz symptome* appear, and though temporarily a little allayed at each injection, do not disappear, and the patient's sufferings are really prolonged. Erlenmeyer himself recognises this, and in 1896 wrote that "for three years he had abandoned the method associated with his name."[1] The *gradual* method is then the one which has found most favour with those in a position to form the best judgments. A case of Dr. Braithwaite's will best illustrate this method. The patient was in the habit of taking 40 grs. of morphia a day.[2] The treatment began with 30 grains, and gradual reduction took place till the forty-second day, when none was given; the injections were given only three times daily, he got 30 grains of bromide of soda at night, and ʒj. Easton's syrup three times in twenty-four hours.

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[1] Of the Schömberg Insane Asylum, Berlin.

[2] *Scribner's Monthly*, vol. xx. p. 416.

One other plan of very gradual withdrawal may in some cases be efficacious. A solution is obtained of the strength used by the patient. Every syringeful withdrawn from the bottle is replaced by an equal quantity of distilled or boiled water. By this means the dose is diminished by infinitesimal degrees, till at last the patient is getting none of the drug at all.

From what has been said it is obvious that it will be almost an absolute necessity for treatment that the patient is removed from his own home, and placed in a special asylum where he can be watched and nursed. It is very exceptional to find any case of successful home treatment of morphinism. It is better that he should not associate with any other patient suffering in the same way, as they will constantly talk of themselves, their doses and pains, and will often plot to carry out some deception to obtain their drug. Besides this, the more the thoughts and conversation run on morphia the harder is it to recover the lost will-power that is so necessary for the struggle. Their surroundings should be comfortable, bright, and cheerful. Their medical and nursing attendants should be attentive, kind, firm, and sympathetic. A good tactful female nurse is much superior to a male nurse. In a case in which the habit was not of long duration, where the daily dose was only 4 to 5 grs., and I adopted the abrupt plan, the patient was controlled and tided over his period of misery, raving, violence, and despair by a young, physically weak, but firm, kindly, and sympathetic female nurse. He was in a private hospital and not under restraint. It is almost certain that with a male nurse, or with any physically strong but less sympathetic attendant, he would have thrown aside all control, left the house, and taken again to his "needle," if he had not done worse by using violence to himself and others.

Besides these general considerations of the treatment, there are some particulars that should receive further attention. While diminishing the dose of morphia valuable help may be obtained from atropine; it arrests the profuse secretions, tending to prevent the occurrence of diarrhœa, and is said to materially allay the *abstinenz symptome*. It is recommended to begin with $\frac{1}{300}$ gr. sulphate of atropine, and to gradually increase the dose, watching closely its effects.[3] Dr. Gerard Smith recommends sulphate of

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[1] *Prog. médicale*, 1st August 1896.

[2] Treatment extending over forty-one days, usual dose 40 grs. per diem :—

1st-2nd day, 30 grs.	9th-16th day, 4 grs.	32nd-36th day, 1 gr.	1 injection thrice daily
3rd ,, 12½ ,,	17th-23rd ,, 3 ,,	37th-41st ,, ½ ,,	30 gr. Na.Br. each night
4th-6th ,, 7½ ,,	24th-27th ,, 2 ,,	42nd-56th ,, 0 ,,	ʒj. Easton's syrup thrice daily
7th-8th ,, 6 ,,	28th-31st ,, 1½ ,,		

[3] *B. M. J.*, 1894, i. Epit. 97.

spartein to lessen the "abstinence storm," and when the pulse shows severe tension, nitro-glycerine or nitrite of amyl gives rapid relief. Dr. Fleming recommends that when insomnia is very protracted tr. of cannabis indica in ʒss. to ʒj. doses should be given at bedtime. The bromides are of decided use in the treatment of a case, and may be given in large doses. Dr. Neil Macleod reported two cases in which a well-established habit was cured by bromide poisoning,[1] and has since tried it in others and strongly advocates it.

The best drug for the insomnia during demorphinisation is trional, given in 40-grain doses to adult males, 30 grs. to females. Sleep follows in from three to four hours, lasts on an average seven to eight hours, and is sound, dreamless, and refreshing. Dr. J. B. Matteson of the Brooklyn Home for drug habitués says:[2] "We use it exclusively for the first six or eight nights, decreasing it gradually to half the initial dose. For the insomnia of morphia habitués it is the most valuable soporific we possess." He advises that when pain is present, the trional should be combined with codeine, and thus it gives satisfactory results.

Erlenmeyer has given a very important contribution to the treatment of demorphinisation.[3] He has found, by means of the stomach tube, that where morphia has been taken there is a great excess of HCl in the stomach. This is due, he believes, to the previous narcotic effect of the morphia on the glands and the dulled sensibility of the nerves, as the morphia is excreted by the gastric glands. When, however, the narcotic source is suddenly cut off, the reverse of this condition obtains, there is hypersecretion of the glands, and the nerves become hypersensitive, hence the extreme gastric and nervous symptoms. He therefore keeps the gastric contents neutralized with large draughts of 0·35 per cent. solution of bicarbonate of soda, with the result that he has treated 30 cases in this way, with total absence of gastric and nervous symptoms, although the craving for the drug remains.

Though it is rare to meet with pregnancy in a morphinomaniac, it does occur, and in such a case great care should be exercised, as any attempt to withdraw the drug is almost sure to be followed by abortion or miscarriage. It should also be remembered, as pointed out by Erlenmeyer, that infants born of mothers addicted to morphia are affected with *abstinenz symptome*. They are, in fact, congenital morphine habitués, and as soon as they are separated at birth from their source of supply, are liable to serious troubles, such as complete insomnia, which in one case lasted for sixty hours.[4] This is quite borne out by the fact that morphia has been found in the blood of the umbilical vessels and fœtal placenta of a new-born child whose mother was a morphinist.[5] Again, should a morphinomaniac be seized by any acute or subacute illness, his morphia must be continued, as, if stopped, symptoms may arise which may puzzle the physician and seriously endanger the patient's life. The case is related in the *Lancet*, of a medical man, a morphia habitué who got pneumonia. Most alarming symptoms of dyspnœa, cyanosis, weak and irregular heart-action, and excessive rapidity of pulse, caused the greatest anxiety for the result, and it appeared that a fatal issue was prevented only by a recognition that these were the *abstinenz symptome* of a morphinist rather than due to the pneumonia, and by a prompt recourse to the stimulant for which the system was craving.

For such an enslaving habit as morphinomania there should be even a more earnest consideration of prophylactic than of curative measures. Most of the blessings that nature has placed within our reach may, by improper use, be turned into evils. Opium is one of these blessings. The immortal Sydenham is said to have stated that he would not practise his profession if he could not administer opium. Both its blessings and its evils are undoubtedly mostly exercised through the agency of the medical profession. The former cannot be given up because of the latter, so it becomes imperative to use every means to guard against the danger. Unless in the case of a fatal illness a hypodermic injection of morphia should not be given, if it can be done without, or if sufficient relief can be obtained by any other form of medication. A patient should never be allowed to inject himself. A prescription for morphia should never be given if it is possible to avoid doing so; if it is given an attempt should be made to prevent its repetition without the prescriber's authority. Legislation might aid us in lessening the evil by more rigorous laws regarding the sale of the drug, *e.g.*, great good might be done if it were made illegal for pharmacists to repeat a prescription for morphia (cocaine or chloral) unless it bore the signature of a medical man with date, ordering it to be so repeated, and the renewal should be countersigned by the pharmacist.

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[1] *B. M. J.*, 1897, ii. 76.

[2] *Med. Record*, 11th December 1893.

[3] *Prog. médicale*, 1st August 1896.

[4] *Jouet*, p. 41.

[5] *Bureau. Report Universal d'obstet. et de gynæcol.* 25th August 1895.

With the exception of mentioning that in 1897 a French civil law court established a will made by a morphinomaniac,[1] we will not go into the medico-legal aspects of the case.

THE COCAINE HABIT is of more recent growth than that of morphia. The drug was only regularly introduced into medicine between twenty and thirty years ago, but already its victims are numerous, and to be found far and near.

In even its legitimate employment it appears to be a more dangerous drug than morphia. The great frequency of very alarming symptoms, and the large number of deaths recorded after its administration called forth an important "leader" from the *British Medical Journal* in 1889, pointing out its dangers and how they were manifested, with numerous cases as examples, and information regarding antagonistic drugs.

As an enslaving drug it appears to be the most insidious, the most rapid in its conquest, the most demoralising in its effects, and the most permanent in the marks it leaves upon the few emancipated ones.

As to the way in which the habit is acquired, there are two principal methods:—

The first and most important, as being the worst, is that in which it is used as a substitute for the morphia habit. The condition of affairs in such a case is, as Erlenmeyer aptly puts it, like the man out of whom a devil having been cast, went and took unto himself seven other devils worse than the first. The picture of the morphinomaniac, lurid and depressing though it is, is but a feeble, hazy outline beside that of the cocaine madman.

A physician who had been an opium eater for several years substituted hypodermic injections of cocaine; he soon got delusions of persecution, hallucinations of sight and hearing, loss of memory, muscular incoordination, and aphasia (*Philadel. Med. News*, 7th Jan. 1894). Another physician substituted cocaine for morphia, and soon became a mental and physical wreck, having to give up his profession and retire to a home where he could be under control, and where he was unable to obtain the drug.

Another method is by its abuse as a true medicinal agent, either where in a really painful affection it is repeatedly taken for relief of this condition and then cannot be given up, or where it is taken for some trivial complaint such as sore throat, coryza, etc., and insidiously constitutes itself a necessity.

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[1] *B. M. J.*, 1897, ii. 496.

As an example of the former may be given the case of a woman, formerly a nurse, who injected herself with cocaine for sciatica, and continued its use till it became a "habit"; a dose of 16 grains brought about collapse and almost death. The medical man who was then called to see her discovered that she obtained the drug regularly "from an unqualified druggist" (*B. M. J.*, 1889, ii. 750).

With respect to the latter cause Dr. Lennox Browne writes a warning against cocaine lozenges, sprays for the nose, and such like; and says: "None but those specially occupied in laryngology and ophthalmology can have an idea of the extent to which excessive indulgence in cocaine is carried." Dr. Zangger of Zürich relates the case of an English lady who was in the habit of taking about 30 grains of cocaine daily. Two years before she had been given a prescription containing 48 grains of cocaine in 2 ounces, as an application for her gums; she continued its use and swallowed it. As the bottle lasted only thirty-six hours, she took about 30 grains a day. In addition she took 20 to 30 grains of chloral hydrate every night to induce sleep. Her condition was one of extreme nervous prostration, morally and mentally affected, with periods of extreme depression followed by undue brightness and activity, and with now and then hysterical paralyses which lasted for one or two days. He gradually reduced the drug to 9 grains daily, but then she suddenly left his care, and resumed her habit (*B. M. J.*, 1896, ii. 123).

Again, a father kept and took a solution of cocaine which he had originally obtained (without prescription) for toothache. His daughter, having toothache, went and took a dose of this. She swallowed about 2 drams at 6.30 and died at 7.30. It was a 10 per cent solution; she had taken about 12 grains (*B. M. J.*, 1895, ii. 1162).

A druggist commenced his habit by using a 4 per cent solution as a nasal spray, and gradually increased its strength till he used 7 grains at a sitting, and presented all the symptoms of a regular habitué (*Phil. Med. News*, 1894, 7th Jan.).

A medical man first used a 4 per cent solution as a nasal spray. He continued it for its stimulating effects, and soon became a victim to the habit (*ibid.*).

The reasons for the danger of these methods of use of the drug are well pointed out by Dr. Lennox Browne. He shows that the drug after long use loses its analgesic effects; that though at first promoting salivary secretion it later causes abnormal dryness of the nose and throat; that though at first it relieves the engorgement of the mucous membrane of the turbinated bones, its prolonged use leads either to anæmia and atrophy, or to increase in the intensity and chronicity of the hyperæmia.

Perhaps the most insidious method of getting into the "habit" is by means of medicated drinks and sweets, such as wines, cocoas, voice lozenges, and the like.

Dr. Milner Fothergill, in the *Practitioner's Handbook of Treatment*, says: "Coca wines, and other medicated wines, are largely consumed by people who consider themselves total abstainers." What wonder at this when in our leading medical journal the public read its testimonials of these abominations, *e.g.*, "The makers adduce medical testimony as to the value of these coca wines in mental and bodily fatigue and in the treatment of nervous exhaustion, with sleeplessness and other affections." This in 1888 (*B. M. J.*, 1888, ii. 1344). Or in 1893 on "Coca champagne," "presented in a form in which it may be used without any misgiving by all invalids, and by those who desire to avail themselves of its tonic and restorative powers. It constitutes a decided and laudable progress in what may be called dietetic therapeutics" (*B. M. J.*, 1893, ii. 1219). They are further recommended as "containing a large proportion of the alkaloid," or "of unusual strength and concentration." This is the worst form of advertising. What wonder that Dr. Snow of Bournemouth feels called upon to write drawing attention to "the increase of intemperance amongst invalids from the enormous consumption of coca wines, some of these wines depending for their alkaloid from the leaves, but some with considerable quantities of the hydrochlorate of cocaine in them"; he says, "the patients not only become alcoholic, but it induces in them what Erlenmeyer calls 'the third scourge of humanity,' the cocaine habit. They become nervous, tremulous, sleepless, with loss of appetite, and finally drift into pitiable neurasthenia" (*B. M. J.*, 1897, ii. 1666).

The effects of cocaine in varying doses, as very fully investigated by Dr. R. Stockmann, is given in his "Report on Cocaine Alkaloids" (*B. M. J.*, 1889, i. 1043). (1) Very small doses excite the sensibility and decrease motility; (2) Larger doses cause a loss of muscular co-ordination—a loss in the power of movement from one place to another, while sensibility is entirely retained; (3) Still larger doses cause diminution and ultimate disappearance of sensation, the excito-motor power being never lost; (4) In fractional doses characteristic tetanus is caused. Mosso pointed out that it increased the body temperature (Mosso, *Cbl. f. die med. Wiss.*, 1886, 372). Its continued use, as in the case of habit, where the tendency is to regularly increase the dose, brings about with comparative rapidity a state of profound mental and moral degradation. Amongst the first ill effects are sleeplessness and anorexia, two conditions which in themselves are sufficient to undermine any constitution. To these are soon added headache, muscular inco-ordination, loss of memory, hebetude, eneuresis; emaciation by this time is well marked, and constipation is always present. Soon delusions appear; they are usually those of persecution, and render the victim very unhappy. He shuts himself up in solitude, only to creep abroad in the depth of night or the stillness of the early dawn. Hallucinations are a constant symptom; these are both of sight, hearing, and common sensation, and Magnan first drew attention to a peculiarity of this latter as a pathognomonic symptom of chronic cocaine poisoning. Magnan's sign is an hallucination of feeling, as of foreign bodies—grains of sand, crystal, worms or microbes below the skin. The value of this sign is insisted on by Rybakoff, who has never found it in any other drug habit, nor in any other case of inebriety (*Mün. med. Woch.*, 1896, 1175). Delusions and hallucinations are not far removed from downright insanity, and according to all observers with the largest experience, Ricord, Kerr, Mattison, these unfortunates, if not saved from themselves by having their liberty taken from them before it is too late, become insane, and when insane the great tendency is towards suicide.

Insanity more frequently follows the cocaine habit than any other drug habit.

Whatever little chance there is of the morphinomaniac breaking himself off his vice, there seems to be none for the victim of cocaine. His only chance is confinement in a home or asylum, and it is questionable if any one who has been addicted to cocaine, after recovery ever regains the mental condition which was his before his introduction to the drug.

The treatment requires, more imperatively than for morphia, that the patient be absolutely under control in an institution from which he cannot escape nor get his drug, and where there are plenty of attendants to watch him and prevent him from doing himself injury. Decocainisation should be by the gradual method. A steady reduction in the quantity of the drug taken should be made daily. Any attempt to suddenly withdraw it or very largely reduce the quantity is likely to be followed by alarming symptoms, mental and physical, mania and collapse.

The greatest attention and care should be given to obtain sleep and nourishment.

He must remain under care and treatment many months before he can be considered well enough to be trusted to take care of himself, and to voluntarily refrain from going back to his drug.

Niel Macleod strongly advocated the treatment of both cocaine and morphia habits by enormous doses of sodium bromide up to ℥j. twice a day, producing thereby a profound bromide narcosis, from which the patient awakes, probably in violent delirium, but having lost the drug crave. He claims that (1) he can cure a case within three days by this treatment; (2) that there can be no possible deception practised by the patient; (3) the patient is sensible of no suffering; (4) it is not necessary to have any special home or institution for the treatment—the doctor with the aid of a nurse can carry it out at the patient's home; (5) there is no risk of substituting a second drug habit.

That the habit is on the increase there is no doubt. This can only be determined by one's own observation, and close scrutiny of the various medical journals. In 1897 over forty victims of the cocaine habit appeared in the police courts of Chicago within a period of two or three months, and the report says the habit is chiefly induced by the using of popular remedies for colds, etc.

This is a serious statement, and shows that legislation is much needed to control the sale of the drug, and particularly its distribution broadcast in that form which entraps the unwary—namely, as in wines, cocoas, and sweetmeats.

Several states in the U.S.A. have recognised this, and in 1899 passed a law prohibiting the sale or giving of cocaine to any person except a duly authorised physician or upon a physician's order. Even in Turkey the Sultan, as long ago as 1892, issued an irade forbidding its use, and that of sulphonal also, throughout his whole empire.

ANTIPYRIN is daily becoming more commonly used by the public in the self-treatment of their real or fancied disorders. This is very evident, not only from the observation of medical men in general, but by noting the large number of cases which appear in the journals, of the occurrence of symptoms of poisoning and of curious rashes, which are reported as arising from this self-treatment.

Antipyrin is most frequently taken by females, usually for headache, and its use has not unfrequently degenerated into a "habit," but to nothing like the same extent as morphia or cocaine.

Antipyrinomania causes a gradual deterioration of the general health, loss of appetite, sleeplessness, apathy—the patient losing all interest in domestic or other matters, and appearing dazed or half asleep until headache and buzzing in the ears causes restlessness, calling for another dose. This, if delayed, brings about great excitement, followed by prostration, which would appear to threaten life if a supply of the drug is not available. Hence they must be treated exactly like a morphinomaniac, that is, placed under control, carefully nursed, and the drug withdrawn very gradually, the prostration, anorexia, insomnia being suitably provided for.

Wechselman[1] records several cases of this habit, and notes the frequency of eruptions, chiefly vesicular, affecting most usually the mouth, hands, genitals.

Other eruptions have been frequently noticed—scarlatiniform over the whole body, hæmorrhagic on the extremities, dusky erythema, stomatitis. Some of these eruptions are painful.

Cuppelletti records a case of the habit in a girl, aged 23, of hysterical temperament. She had been recommended to take the drug two years before for headache, and had continued it steadily, increasing the dose up to 8 grammes daily (about ʒxx.) At this time she came under treatment, and was eventually completely cured.

It is probable that the misuse of this drug will now be rarer than it was some some years ago, as in 1892 a regulation came into effect prohibiting its sale without a medical prescription.

ANTIFEBRIN is also responsible for some victims of "habit." Here again women are the chief sufferers. They generally take the drug for headache or neuralgia, and finding perhaps temporary relief continue it, but require increasingly large doses, and then find they cannot give it up.

Its prolonged use causes a peculiar appearance, which attracts attention and gives a clue to the patient's secret. The skin becomes moist and clammy, and a peculiar leaden-blue tint is noticed, especially of the conjunctivæ, ears, lips, tongue, fingers, and toes, but it may be general. The blood appears darker than normal, but otherwise shows no important change. The patients complain of langour and general malaise, for which they seek medical advice.

The most common source of the drug in these cases has been some of proprietary medicine. In 1896 an inquest was held on a young woman who died from the effects of "daisy powders for headache." These were found to be composed mainly of antifebrin. Several other cases of chronic poisoning from the same source, and also from "kaputine" powders, which are mainly antifebrin, have been recorded.

PARALDEHYDE habit is by no means unknown, though it is not common. The drug is usually taken at first for insomnia, and the habit is soon acquired.

The patient becomes anæmic, weak, anxious, tremulous, and restless, with unsteady gait; the heart becomes feeble, irregular, and intermittent; there is great emaciation, although there always appears to be an abnormally large appetite. The breath smells strongly of the drug. Mental symptoms may appear, including hallucinations of sight and hearing, also various delusions.

The case may be mistaken for delirium tremens on account of the tremor, gait, emaciation, and condition of the heart; or for diabetes, from the emaciation and enormous appetite.

As with the other "habits," the patient must be treated in a home or asylum by gradual withdrawal of the drug, sleep being obtained by sulphonal.

Kraft-Ebing mentions the case of a woman who had for a year taken 4 grammes (ʒx. nearly) daily. Goodman instances a woman who took, in increasing doses, up to 16 or 18 ounces in 24 hours. She was a complete wreck, covered with a vesicular eruption, which smelt strongly of paraldehyde. Elkins[2] relates the case of a man, æt. 63, who had been taking paraldehyde for 2½ years for insomnia; he took up to 16 ounces in a week. After 3 months' treatment in an asylum he was discharged cured.

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[1] *Deut. med. Woch.*, 26th May 1898.

[2] *Ed. Med. Journ.*, July 1893.

CHLORODYNE habit is not uncommon, and it is remarkable how many of its victims become the subject of a coroner's inquest. Though a drug very much used by the public in their self-treatment, especially for the relief of abdominal pain, diarrhœa, toothache, and insomnia, it appears to be the last, viz. insomnia, which is responsible for most of the victims of the habit.

The condition of these chlorodyne slaves becomes much the same as that of an opium or morphia habitué. At an inquest lately, the friends of the victim said that he would sometimes lie senseless for hours after taking a tablespoonful of the drug. At another inquest it came out that the woman drank two or three 2-ounce bottles per week.

Their treatment must be carried out on the same lines as that of a morphinomaniac.

EAU DE COLOGNE, SALVOLATILE, and ETHER drinking may be called habits, but should be more properly considered with alcoholic intoxicants. The first two are not common, and are of necessity almost confined to the upper classes of society. Ether drinking is or was very common in some districts, notably the North of Ireland — two or three rapid, evanescent ether intoxications on a market-day being considered better value than one long whisky debauch.

Not long ago a man was arrested in Kensington, and "it transpired that he was addicted to the self-administration of chloroform, an odd kind of mania." He was discharged pending arrangements to admit him to a home. This, however, must be a very rare habit indeed.

Drug-habit victims rarely offend against anybody except themselves, and indirectly, their friends. They do not appear to swell the criminal class to any appreciable degree. I have not come across any account of criminal proceedings against such unfortunates. Dr. Revington of the Central Criminal (Lunatic) Asylum of Ireland informs me that he has no such case under his charge, nor does he know of any.

To all who have fallen under the enslaving influence of drug-habit we should extend our pity and lend a helping hand, not passing them by "on the other side" from either loathing, contempt, or self-interest.

Morphœa (see also "Scleroderma," and "Sclerema Neonatorum").—The term is applied to a circumscribed induration of the skin, usually in the form of areas of considerable size, in which the skin has a dead white appearance, and feels inelastic and brawny to the touch. The onset of the condition is frequently rapid and apparently causeless. When developed the patches tend to persist, but occasionally disappear. Sometimes it is associated with slight sensory elevations in the affected areas, this lending support to the view that this is a nerve affection. In other cases sensory changes are slight or absent. The most common site is the upper part of the trunk. The etiology and the pathology of the condition are unknown, and in the absence of exact knowledge the condition is usually regarded as a trophic neurosis. The subject will be further considered under "Scleroderma," of which Morphœa is really one of the varieties.

Morvan's Disease.—This affection is really a type of syringomyelia associated with marked trophic disturbances in the form of painless destructive whitlows. There is much about the disease that is still obscure. Whether the condition of the fingers is entirely dependent on the cord lesions, or whether dependent on a coincident neuritis is still unknown. The clinical features, diagnosis, prognosis, and treatment will be discussed under "Syringomyelia."

Mountain Fever.—A form of fever described by Osler as occurring in the Western States. The disease is unknown in this country. Recent investigations by Woodruff, Raymond, and others, prove that this condition is really typhoid fever, the blood giving the Widal reaction. For that reason it would be well for the use of the term mountain fever to be discontinued (Osler).

Mountain Sickness.—This is a term that has been applied to the series of phenomena that are familiar to, and have been recorded by experienced mountaineers, especially those who climb to very high altitudes. Though termed mountain sickness, it might also be called balloon sickness, since it also presents itself when high elevations are attained during aerial navigation. The symptoms are quick pulse, rapid breathing, and a feeling of constriction and incapability for exertion. The increased respiration is accompanied by spasmodic gulps, resembling the gasping of fishes when taken out of water. Conway writes that on the summit of Pioneer Peak, 23,000 ft., "we ceased to pant for breath the moment the need for exertion was withdrawn, and a delicious lassitude and forgetfulness of past labour supervened upon our overwrought frames." All felt weak—ill, like men just lifted from beds of sickness. Intense headache is a constant symptom; so also is palpitation, which is familiar to all climbers, even at lower levels. At slightly higher levels the symptoms are intensified, the more prominent being giddiness, nausea, loss of strength in the limbs, and the escape of blood from the superficial capillaries, *e.g.* the nose. The last mentioned is indicative of the general engorgement of the venous system that is present in the later stages. Sensations of feverishness have also been described, but no observations with a clinical thermometer have been made to prove this point. Conway made accurate thermometrical observations, and says, "Bruce's temperature and mine were both normal, notwithstanding that we felt plainly discomfort from the reduced atmospheric pressure.

Hæmorrhage, such as epistaxis, gum-bleeding, and bloodshot eyes, occurs from rapid diminution of atmospheric pressure, but does not seem to be present in mountaineers under ordinary circumstances. Nausea and vomiting are popularly supposed to form part of the group, but are probably due to other causes, such as fatigue or disordered digestion from unsuitable food. Mountain sickness is felt more in sun than under cloud, and more in a trough where the air feels stagnant than in a wind.

The causation of these symptoms has been put down to diminished barometrical pressure, heart failure, indigestion, deprivation of oxygen, fatigue. These factors all seem to act more or less, but the immediate and sufficient cause is deprivation of oxygen. This brings about an involuntary increased frequency of respiration, and to compensate this, the respiration becomes more shallow. As a result the lungs become more contracted, and accommodate less blood, and venous stasis with deficient oxidation ensues. Alterations in tissue metabolism occur, leading to increased hæmolysis in the liver, and an altered distribution of the corpuscular elements in the blood.

LITERATURE.—ALLBUTT's *System of Medicine*, vol. iii., with full bibliography.

Mouth—Diseases and Injuries of the Mouth and Jaws.—It is convenient to describe these in the following sections—the first dealing with the diseases of the lips, cheeks, gums, and floor of mouth, the second treating of injuries and diseases of the jaws. The important subject of oral sepsis will be discussed in the section on teeth.

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Diseases of the Mouth

In this cavity the organs differ so in character and function that it is impossible to give a connected account of its surgical diseases, *e.g.* the treatment of the teeth requires such special methods that a distinct class of practitioner devote themselves exclusively to this subject, and the reader is referred to the article on "*Teeth*" for information concerning these organs.

The *tongue* is the seat of numerous pathological conditions, both medical and surgical in their bearings, and consequently a special article is necessary for dealing with so extensive a subject.

In the case of the *palate*, both hard and soft, the pathological conditions are not numerous or of very common occurrence; but a special interest is attached to its congenital malformations, and therefore it is very convenient to deal with the whole subject of palate under a separate article.

In addition to these organs certain important glands discharge their contents directly into the mouth, and of these the most important are the salivary glands. These organs are liable to diseases both in the glandular substance and in their ducts, and the whole subject is better dealt with under a special article, where an account of parotid fistula and salivary calculus will be included. Excepting these organs there are remaining only the three boundaries of the mouth: anteriorly the lips, laterally the cheeks, and inferiorly the floor of the mouth and the gums.

The botany of the mouth is a large subject comprising an enormous number of microbes and fungi, and it will be dealt with at some length in other places of this work. Microbes and other parasitic diseases of the mouth are especially common amongst children, hence in the article dealing with stomatitis the reader will find ample information on these interesting diseases which for the most part belong to the domain of the physician.

In the article on Teeth the reader will find information concerning the active part taken by micro-organisms in diseases of these organs; and the curious parasitic disease *actinomycosis* is described, as far as its presence in the mouth is concerned, in the section dealing with diseases of the jaws (see page 163). Further, a reference to the important part played by micro-organisms in certain suppurative diseases of the jaws will be found elsewhere.

In addition to microbes and fungi there are at least two very potent factors in producing pathological conditions of the mouth, viz. tobacco and alcohol: the former when inhaled, especially through a pipe; the latter when taken in concentrated form, as in various spirits. As these causes act especially on the tongue the reader is referred to the article on that organ for full consideration of the effects of these poisons.

In considering the special regions of the mouth to which this article is devoted, one is first of all struck with the resisting character of two of its constituents, namely, the lips and the cheeks, especially their mucous surfaces. This is well shown by the way in which *lupus vulgaris* of the face spreads. It is comparatively rare to find this disease spreading into the mouth and affecting the buccal mucous membrane, whereas the disease very often spreads along the nose and down the throat, so that lupus of the pharynx is much more common than lupus of the mouth. Again, although the buccal mucous membrane is subjected to the irritation of decaying teeth, yet malignant disease commencing in this region is much less common than malignant disease of the tongue or floor of the mouth.

Many of the diseases affecting the mucous membrane of the lips and cheeks are fully dealt with in the article on Tongue, *e.g.* leucoplakia, dental ulcers, etc., and the reader is referred to that article for full information on these diseases.

It will be convenient, in considering our subject, to divide it into four parts, the lips, the cheeks, the gums, and the floor of the mouth.

1. DISEASES OF THE LIPS.—Among the inflammatory diseases there are a few deserving mention owing to the manner in which they are modified by the peculiar relations of the lips. *E.g.*, a boil may cause a very wide disturbance in the lip owing to the ease with which inflammatory exudation travels in the tissues of this part, producing marked swelling and œdema. In addition, the constant movement of the lips, together with a great liability to traumatism, produces secondary phenomena which may completely conceal the primary boil. The lip becomes markedly everted, and the primary lesion may be quite concealed unless a very careful examination be made. In the same way *anthrax* occurring at the muco-cutaneous margin may become concealed by the secondary inflammatory disturbance.

In *cancrum oris* there may be extensive gangrene of the lips, and the reader is referred to the article on that subject (see "STOMATITIS").

There is a certain condition of the lips, sometimes called hypertrophy of the lips, which seems to be due to a chronic inflammation of its lymphatic system. It is said to occur especially in children of the tuberculous tendency. According to some authors, the glandular disease met with in these patients when occurring in the glands draining the lips causes a certain amount of lymphatic obstruction and consequent overgrowth. The exact pathology of this condition, however, is not known. There is a well-recognised disease termed *congenital hypertrophy* of the lips. This is always present at birth to a slight extent, although it may not develop markedly until some years afterwards. This seems to be due to some chronic disturbance of the lymphatic system of the lips, but its exact pathology is even more obscure than the cases just described. The treatment of these conditions is purely operative. Plastic operations are necessary to reduce the marked hypertrophy.

As regards *tuberculous diseases*, there is nothing of special importance when occurring in the lips. *Lupus vulgaris* may spread from the face, but is comparatively rare as a primary disease of the lips.

Syphilis is met with in the lips in all its stages, but the primary chancre of the lips has a certain special interest from two points of view. One is the fact that it is the most common site for primary syphilis next to the congenital organs; the other is the fact that the diagnosis is often overlooked until the disease has got a firm hold of the system. Owing to the constant moisture and the secondary septic inflammation, the swelling of the lips becomes very marked, and there is often considerable inflammation in the submaxillary lymphatic glands. The course of treatment requires no special comment.

Tumours of the lips are not of very common occurrence if we except epithelium of the lower lip. They may be grouped as follows:—

(1) *Vascular Tumours.*—Nævi of the lips occur rather commonly among young children. They may be simply *capillary*, limited quite to the surface of the mucous membrane, or they may be *cavernous*, affecting the lip quite deeply. The latter are of some interest because a considerable amount of the lip may require removal.

(2) *Connective Tissue Tumours.*—These consist of lipomata, fibromata, myxomata, and sarcomata, and do not differ from similar growths elsewhere.

(3) *Glandular tumours* consist of cysts originating in some of the labial glands; adenomata originating in similar glands, forming solid masses of glandular tissue, and a mixed tumour similar to the well-known parotid tumour containing both glandular tissue, myxomatous tissue, and cartilaginous tissue.

(4) *Epithelioma of the Lips.*—This disease nearly always occurs in the lower lip, and as a rule in men. It originates at the muco-cutaneous line, and may occur at any point along the lower lip. It has a special tendency to occur at a spot where the pipe is habitually held. Indeed this agency is undoubtedly the chief cause. It does occur occasionally in non-smokers, and in women, although in one case described the woman was a smoker. The disease seems, as regards malignancy, to stand in an intermediate position between epithelioma of the skin of the face and of the tongue. The disease commences as a small overgrowth of epithelium, and is generally considered by the patient to be a wart, and consequently advice is often not sought for until the disease has advanced considerably. After a time the epithelium becomes abraided, and there is a raw surface which, being constantly moist and constantly soiled, shows considerable secondary inflammatory disturbance. As regards treatment, complete removal of the growth is indicated as soon as its nature is recognised. In the early stages it can be most completely removed by excising a V-shaped piece of lip, keeping well clear of the growth on each side. Quite a large piece of the lip can be removed in this way with scarcely any deformity. In advanced cases a plastic operation may be necessary.

Deformities of the Lips.—These fall into two main groups:—

(1) *Stricture of the Mouth.*—This, of course, is a narrowing of the oral orifice, and may be the result of ulceration at the angles of the mouth, and as the result of lupus, syphilis, etc. It may follow marked loss of substance of the lips, as after burns, surgical operations, cancrum oris, etc. Together with the loss of substance the lips may be adherent to the jaws, in which case the inconvenience and deformity is very great.

(2) *Ectropion of the Lips.*—This may be caused by enlargement of the mucous portion of the lip as in congenital hypertrophy, or it may be due to cicatricial contraction of the skin in the neighbourhood of the lip.

2. Diseases of the Cheeks.—There are not many points of special interest in the surgery of the cheeks. All the inflammatory and special diseases met with in the lips may occur in the cheeks. As regards the tumours of the cheeks, there is a special interest attached to *lipomata*, inasmuch as they may develop in the lobule of fat at the anterior border of the masseter known as the pad of Bichat.

A fact not usually known is the presence of small lymphatic glands in the tissues of the cheek generally below a horizontal line drawn through the mouth. One is often found close to the facial artery just over the buccinator muscle. In inflammatory lesions of the cheek the small glands become enlarged and are then quite evident. The author has on several occasions found such swellings, and has proved their lymphatic glandular nature. Epithelioma may occur, either originating in the skin of the cheek or in the mucous membrane. A rare growth met with in the cheek is one originating in the socia parotidis.

3. Diseases of the Gums.—There is a rather rare and curious affection known as *hypertrophy of the gums.* It occurs in children, generally appearing within the first year of life. The appearance is a very remarkable one. The gums are everywhere gradually hypertrophied, forming projecting masses which may almost completely hide the teeth, at first the masses being the natural colour of the gums, but later on ulceration occurs, and septic changes produce ulceration and gradual destruction of some of the masses. On careful examination it will be found that this condition is associated with an enlargement of the jaws, especially the alveolar processes, and as a rule the patients are mentally very defective. Occasionally there is a hypertrophy of the gums produced by the mechanical irritation of badly-fitting artificial teeth. The treatment of hypertrophy of the gums consists in a free removal of the soft tissues, together with the portion of alveolus to which they are attached. Unless some of the bone is removed the hypertrophy nearly always reforms. In the case of the hypertrophy from mechanical irritation the badly-fitting teeth must be rectified and the hypertrophied portion excised with a knife.

Vascular growths are sometimes met with in the gums, especially in the region of the incisor teeth. They seem to be composed of cavernous tissue, and are evidently a form of nævi. They cause considerable trouble because they bleed freely when the tooth-brush is used, and if not removed they may grow to some considerable size, and may form a nasty ulcerating mass.

Papilloma of the Gums.—Occasionally rather fine papillomata are found growing from the gums, especially in the upper jaw. Some of these have afterwards become malignant and develop definitely into an epithelioma. It is important, therefore, to remove a papilloma of the gum as soon as it is recognised.

Epulis.—This term requires some explanation. Originally it was applied to any tumour which appeared to grow from the gum; thus it included an ordinary epulis, a papilloma, a sarcoma of the alveolar process, or an epithelioma. It is obvious that if the term epulis be used in this wide sense considerable confusion must arise in discussing them. It is better, therefore, to restrict the term to the characteristic growth which commences at or near the neck of a tooth. As a matter of fact, the true epulis is not primarily a growth of the gum, but of the periosteum beneath the gum. They really belong to the group of sarcomata although they need not necessarily have a malignant tendency. The tissue of the gum and its epithelium are simply stretched by the growth from the underlying periosteum, and therefore the changes in the gum itself are really secondary. The tumour, therefore, is always composed of connective tissue. Sometimes the fibrous element predominates so much over the cellular element that they are sometimes looked upon as belonging to the fibromata. In many of them there is a development of bone to a greater or lesser extent, which can be found on careful microscopic examination in nearly all cases. Their origin from the periosteum is further shown by the fact that they have a great tendency to recur after removal unless the small portion of the alveolus to which they are attached is taken away as well. Some of these tumours present to the naked eye and microscope the appearances of myeloid sarcoma. In all probability both these forms occur, either originating in the periosteum, when we get the ordinary fibrous or the osteo-sarcomatous epulis, or in the bone itself producing the myeloid growth. While it is most important to recognise the essentially sarcomatous nature of the ordinary epulis, yet we must bear in mind that clinically they present considerable differences from ordinary sarcomata of bone. They undoubtedly possess a very slight degree of malignancy, so that when small they seldom recur after removal. Even when of considerable size they do not tend to recur if the portion of bone to which they are attached is removed at the same time. The typical place for an epulis to form is between two teeth, generally growing from the alveolo-dental periosteum at the neck of the tooth, so that when the tooth is extracted the epulis may come away attached to the neck of the tooth. As the growth increases in size the teeth on each side of it become separated, and later on it may become large enough to almost conceal one or both of the teeth. If one or both of the adjacent teeth have been much destroyed by decay the stumps may become completely concealed by the growth, and may even be found embedded in the mass. Later on secondary changes take place due to mechanical irritation. The epithelium on the surface becomes abraided and an ulcer may form. Septic inflammation may progress and vascular granulation tissue may develop, producing a fungating foul smelling mass. In former years the ordinary fibrous epulis was allowed to reach an enormous size, completely disfiguring the patient.

The *treatment* is at the present day quite straightforward. Nothing short of a complete removal of the growth is of the slightest use. If the epulis is very small and can be recognised to have its attachment at the neck of the tooth, the growth will often come away in a complete state when the tooth is extracted. In all cases it is necessary to remove the portion of alveolus from which the epulis is actually growing. The best method, therefore, is first of all to extract any tooth touching the growth; then to cut down to the periosteum around the growth and detach it together with the periosteum from the alveolar process; the exposed portion of alveolar process is finally chiselled away.

Epithelioma of the Gum.—This nearly always originates in the neighbourhood of a decayed tooth. It does not present any special feature differing from epithelium elsewhere. It is possible to get a septic ulceration of the gums simulating epithelioma, but a few days' careful treatment with antiseptics will soon enable the diagnosis to be made certain. The treatment consists in a free removal of the soft tissues and of the bone to which it is attached.

4. DISEASES OF THE FLOOR OF THE MOUTH.—Certain *inflammatory lesions* may involve secondarily the floor of the mouth. There may be a localised inflammation in the supra-hyoid region beneath the deep cervical fascia, causing swelling and œdema in the floor of the mouth. This nearly always terminates in suppuration, and is best opened by an incision through the skin in the middle line between the chin and the hyoid bone. A much more extensive inflammation resulting in gangrene may occur beneath the deep cervical fascia extending upwards to the floor of the mouth. It was first described by Ludwig, and therefore is sometimes termed *angina Ludovici.* This gangrenous cellulitus chiefly destroys tissues in the neck, and is described when dealing with that region. Here it is simply necessary to point out that there may be considerable swelling and œdema in the floor of the mouth at quite an early stage, before extensive mischief in the neck renders the disease quite evident.

Of considerable interest are *swellings* in the floor of the mouth of a cystic nature. These may be classified in three groups:—

1. *Dermoid Cysts.*—Although congenital in origin these seldom begin to show themselves before the period of adolescence, and may not become evident until old age. Their structure does not seem to differ from that of dermoid cysts elsewhere. Some of them undoubtedly are formed by a fold of skin or sometimes of mucous membrane between Meckel's cartilage and the inferior maxilla. Some, however, form from a cleft posterior to the inferior maxilla, which is seen in the case of cysts adherent to the hyoid bone. They form a swelling in the supra-hyoid region externally, and in the anterior portion of the mouth internally. They are situated in the median line, and the swelling in the mouth may appear to be slightly bilobed owing to the attachments of the tongue to the genial tubercles. The most satisfactory *treatment* is to remove them by incising the skin in the middle line below the chin and dissecting them carefully from their surroundings. If very much adherent it may be possible to remove only portion of them. The remainder of the interior must be scraped with a sharp spoon and the surface destroyed with a powerful caustic such as chromic acid. If any small part of the lining membrane is left intact the cyst may reform.

2. *Hydatid cysts* of the floor of the mouth are very rare and need not detain us.

3. *Ranulas* are very common swellings in the floor of the mouth. The name is a curious one and its origin is obscure. It has been suggested that the swelling causes a difficulty of speech somewhat resembling the croaking of a frog; another is that when the swelling in the floor of the mouth is large the characteristic appearance of a frog's mouth is simulated.

Pathological Anatomy.—At one time the swelling was considered to be due to a dilatation of Wharton's duct owing to some obstruction at its orifice. In the great majority of cases, however, this view can be easily disproved by passing a fine probe along the duct. In all probability no ranula has ever been formed in this way. Another view was that they were caused by a blockage and subsequent distension of certain glands in the floor of the mouth first described by Blandin and by Nuhn. These little glands are situated on each side of the frenum linguæ, and from their position might conceivably cause such a swelling when enormously dilated. There are numerous small glands in the floor of the mouth, and no such swelling ever forms in connection with them. At the present day most pathologists admit that a ranula originates in some portion of the salivary glands, usually the sublingual, perhaps occasionally the submaxillary. The exact mode of their formation is, however, obscure. One suggestion is that they originate in abnormal outlying lobules of the sublingual glands, which undergo some curious form of degeneration. In support of the view that ranulas originate in connection with salivary granular tissue, is the fact that in microscopic sections of the wall of the cyst groups of lobules of the salivary type in various stages of degeneration are seen. As a rule the cyst is situated immediately under the mucous membrane of the floor of the mouth, between it and the mylo-hyoid muscle. In some cases, however, the swelling is situated on the other surface of the muscle between it and the deep cervical fascia, hence two varieties of ranula are spoken of—the sublingual or ordinary form and the supra-hyoid ranula. According to some authors the supra-hyoid ranula originates in connection with some portion of the superficial part of the submaxillary gland. This, however, is denied by Morestin, who has found small lobules of the sublingual gland projecting through the fibres of the mylo-hyoid muscle. The most recent view, therefore, is that a ranula originates in some part of the sublingual salivary gland, either from the main mass of the gland when the ordinary sublingual ranula is formed, or by superficial prolongations of the gland through the mylo-hyoid muscle when the supra-hyoid or submaxillary ranula is formed. Microscopically the cyst wall is formed of a thin cellular membrane lined by either a cubical or a stratified epithelium. The contents of the cyst consist of a substance which microscopically rather resembles saliva, although it is denser and less limpid, having rather a viscous consistence. Chemically it differs by having a much greater quantity of mucus, the absence of the diastatic ferment and of sulpho-cyanide of potassium.

Symptoms.—It forms very gradually, and at first causes no trouble whatever. It usually commences on one side of the middle line, but as soon as it becomes large it spreads over to the opposite side and has a bilobed appearance, being crossed down the centre by the frenum linguæ. As it gets larger and larger the swelling becomes more and more symmetrical, until finally it may be impossible to say upon which side it may have originated. The floor of the mouth is stretched over it and presents a grayish pink or grayish blue colour. The mucous membrane glides over the swelling. The cyst is not at all tense unless it is squeezed between the fingers. When its size is very great it may form a swelling between the chin and the hyoid bone externally, and in such cases there would be considerable difficulty of mastication and sometimes of respiration.

Treatment.—This is by no means an easy matter, especially when the cyst is a large one. The best method is to cut away a fairly large piece of the wall of the cyst, taking care to avoid Wharton's duct. The contents are then evacuated and the cyst wall rubbed with some form of caustic. The writer has found that pure chromic acid rubbed over the whole interior of the cyst is generally successful. The cavity is lightly plugged with a little strip of gauze or lint. This is changed once or twice daily, and the cavity washed out with a mild antiseptic lotion.

Erectile tumours are sometimes met with in the floor of the mouth, and were formerly termed blood ranulas. They are really some form of cavernous nævi. Occasionally a *lipoma* is met with in the floor of the mouth, and used to be termed fatty ranula. It would be impossible to distinguish them from dermoid cysts.

Epithelioma originating in the floor of the mouth is sometimes met with. It differs scarcely at all from epithelioma of the tongue. Owing to its proximity to the lower jaw the growth tends to become adherent to the bone earlier than in epithelioma of the tongue. Beyond this fact there is nothing very special in epithelioma in this situation.

Injuries and Diseases of the Jaw

FRACTURES—SUPERIOR MAXILLA

Etiology and Pathology.—The cause is nearly always a *direct* blow upon the face in the region of one or both superior maxillæ, such as the kick of a horse, a blow with a truncheon, or wounds caused by artillery, especially segment shells. The disrupting force may be *indirect,* very rarely from above, the frontal bone being driven into the maxillæ; more often a blow on the chin may cause a fracture of the maxillæ. A fracture of a portion of the maxilla is common enough; very often the force bears directly on the superior maxilla, as in the extraction of teeth, when the alveolar process may be more or less damaged in the region of the tooth. Fractures of the palatal process, or of the anterior wall of the maxilla, may be caused by foreign bodies being pushed inwards, *e.g.* the end of an umbrella or stick, gunshot wounds, etc. A localised fracture may be caused indirectly by blows upon the zygomatic arch or malar bone.

A systematic description of most of the fractures of the superior maxillæ is impossible; no two accidents are exactly alike in their results. There are, however, two well-recognised extensive fractures affecting both bones.

(1) *Transverse fracture* caused by a blow, especially the kick of a horse, striking the maxillæ just below the nose and separating them into an upper and lower portion, the line of separation being about half an inch below the malar process laterally, and through the vertical plate of the palate mesially; the pterygoid processes may be separated and remaining in lower fragment; the lower fragment may then be driven back against the posterior wall of the film.

(2) *Vertical fracture,* in which the two superior maxillæ and the two palate bones are separated to the extent of one-third of an inch.

(3) *Comminuted fractures,* from the passage of vehicles over the face, the effect of gunshot wounds, etc., are not uncommon.

Complications.—In cases where great violence has been at work the cranial bones may be fractured, and injuries to the brain and its membrane may be present. When the alveolar process is fractured the teeth may often become separated or loosened. Hæmorrhage from some branch of the internal maxillary artery or from the main trunk may occur. Secondary hæmorrhage is by no means infrequent after extensive fractures of the upper jaw. Injury to the infra-orbital nerve, with resulting anæsthesia in its area of distribution, and sometimes neuralgia may occur. In all cases where the fracture involves parts of the bone covered by gum or mucous membrane of the mouth the danger of septic inflammation must be borne in mind.

Symptoms and Diagnosis.—In the majority of cases the signs are very evident, like those of fracture in any other part of the body: crepitus with pain on movement, mobility of a part usually fixed, more or less deformity of the face, hæmorrhage from the mouth or nose, and ecchymoses in the soft tissues near the seat of fracture. In certain cases there may be no marked evidence of any fracture. The presence of a fracture may be elicited by careful manipulation and by examining for any tender region. In obscure cases stress should be laid upon hæmorrhage into the mouth and nose. More especially ecchymoses should be looked for in the mucous membrane of the palate, and after some days in the conjunctiva.

Fractures involving the maxillary sinus may be accompanied by surgical emphysema of the eyelids and cheek. Loss of sensibility in the zone of distribution of the infra-orbital nerve and of the anterior and posterior dental branches should be looked for. The finger should reach well to the site of the pharynx for evidence of the mobility of the pterygoid processes. Later on, *secondary symptoms* are of importance. Among these are septic infection in cases where the soft parts over the seat of fracture are torn and are exposed to microbic invasion. Septic complications, however, are much rarer in fractures of the upper jaw than those of the mandible.

Treatment.—It is most important to remember that, however comminuted the fracture may be, all the fragments, even those only slightly adherent, should be preserved. It is well recognised that these comminuted fractures nearly always become united. If the fragments be in direct communication with the mouth, antiseptic washes and insufflations of iodoform powder are necessary. The diversity of fractures of the superior maxilla being so great, it is impossible to describe the various methods that may be necessary for maintaining the fragments in proper position. In many cases the fragments are not loose and remain firm in their proper position, so that no apparatus is necessary. In fracture of the alveolar process the fragments can be kept in position by some form of inter-dental splint or by some method of wiring the teeth together, as will be described in treating of fractures of the lower jaw. In cases where the anterior wall of the maxilla is fractured and depressed it may be necessary to perforate the *antrum* through the canine fossa, and to introduce an instrument in order to force the wall outwards. In cases where there is suppuration of the two maxillæ it has been found necessary to use a steel spring, passing round the back of the head and terminating in front in two pads, which press upon the cheeks and force the maxilla together.

MANDIBLE

Etiology and Pathology.—As a rule the fracture is produced by *direct* violence. Among the many causes are blows received on the jaw whilst fighting, the kick from a horse, or a fall from some height. Very serious fractures, especially comminuted ones, may be caused by gunshot wounds. Localised fractures of the alveolar process are often caused during the extraction of a tooth. Very rarely in a new-born child the lower jaw has been fractured during difficult labour. The fracture is very seldom caused by *indirect* violence. These are nearly always caused by muscular action, such as a severe fit of coughing, etc. The simplest fractures are fissures, commencing in the outer compact layer where the direct violence was applied, and nearly always involving the inner layer. Incomplete fissure fractures may exist, but are of no practical importance, excepting perhaps in the region of the inferior dental nerve, which may be injured at the time, or may undergo pressure during repair of the fracture. Complete fractures of the mandible occur in several regions of the bone; about 90 per cent occur in the body, which is more exposed to injury and also less protected by muscles than the ramus. The most common seat of fracture is in the neighbourhood of the canine teeth and mental foramen, this being the weakest part of the bone. A fracture sometimes occurs in the middle line, either exactly at or very near to the *symphysis menti.* A fracture of the ramus of the lower jaw is unusual, and generally occurs either at the angle, the neck of the condyle, or the coronoid process.

Symptoms.—Fractures of the body and of the jaw are easily recognised; it is when the ramus is fractured that difficulty may be met with in recognising definitely its existence.

Deformity.—This is nearly always present when the fracture is in front of the masseter and internal-pterygoid muscles. The larger anterior fragment is displaced downwards, and the smaller posterior fragment outwards, so that it overlaps the anterior fragment. Sometimes the converse exists—the anterior fragment overlaps the posterior. The fracture through the body is nearly always oblique, the anterior larger fragment being fractured at the expense of its internal surface; and the smaller posterior fragment at the expense of its external surface; but the converse is sometimes met with. The displacement of the anterior fragment in a downward direction is due to muscular action, chiefly the muscles passing from the lower jaw to the hyoid bone. The posterior fragment is pulled firmly upwards by the temporal masseter and internal pterygoid muscles, so that the teeth are pressed against those of the superior maxilla. The outward displacement of the posterior fragment may be in part caused by the action of the temporal and masseter muscles, but it is chiefly due to the direction of the violence causing the fracture.

In fractures of the neck and the condyle the displacement is considerable, as the external pterygoid pulls the condyle inwards and forward, thus causing the rest of the jaw to deviate to the same side, being pulled over by the unopposed action of the other external pterygoid. When the *coronoid process* is fractured the displacement may be considerable, but as a rule it is only slight owing to the prolongation of the tendon of the temporal muscle on to the body of the lower jaw.

Mobility.—The degree of movement that is present depends upon the seat of the fracture. In fractures of the body it is usual to find considerable movement, but when the ascending ramus is fractured there is usually but slight mobility. Very marked mobility occurs when there are two fractures of the body—by no means an uncommon accident.

Crepitus.—This can nearly always be obtained, even if there is very little mobility.

Pain.—This, as a rule, is severe. It is made much worse when the gums are much lacerated or when the inferior dental nerve is injured.

Hæmorrhage.—There is generally a certain amount of blood in the mouth caused by the injury to the gums. It is seldom severe.

Escape of Saliva.—This is very often present because the proper movements of the jaw, cheeks, etc., cannot be carried out, and so the saliva is not readily swallowed.

Complications.—In fractures caused by very severe direct violence there may be wounds of the face which usually heal very well with ordinary treatment. Serious hæmorrhage is very rare, because, as a rule, the inferior dental artery escapes injury. Secondary hæmorrhage is now very seldom met with. The most frequent complication is loosening and dislocation of the teeth. It is most important to ascertain that no tooth or part of a tooth lies between the fractured ends, as this is one of the most common causes of non-union of fractured jaw. As nearly all fractures of the jaw are compound, there is usually present some degree of septic inflammation. Occasionally the septic process is confined to some space and may lead to the formation of an abscess. Where the inflammation is extensive, more or less necrosis of the lower jaw may result. It is very unusual for the inferior dental nerve to be injured. It may be torn, however, at the time of the accident, and occasionally neuralgia may develop some time after the accident owing to pressure exerted by the repairing bone upon the nerve. Where the violence has been very great there may be a dislocation of the lower jaw as well as the fracture.

Treatment.—Innumerable methods for treating fractures of the jaw have been described. In all cases, however, there are certain principles of treatment, whatever the accident and situation of the fracture may be, and these principles must be most carefully adhered to.

(1) Great care must be taken to reduce the displacement, and special attention must be directed towards restoring the normal position of the teeth. This restoration of the "bite" is most important, and every care should be taken to obtain it.

(2) Every effort should be made to get the mouth and its contents as clean as possible. The teeth should be thoroughly cleaned and, if necessary, scaled, so that no trace of tartar should be left, for this is a favourite nidus for decomposition. The tongue should be kept clean by scraping. In order to keep the mouth clean, antiseptic mouth-washes should be frequently employed. In cases where there is marked decomposition, insufflation of iodoform powder is the best agent.

(3) Absolute rest of the lower jaw is necessary for rapid and accurate union. Whatever method may have been employed to fix the broken ends, it is necessary to forbid the patient to speak or to use the jaw for masticating purposes. In order to feed the patient it is convenient to fix an india-rubber tube on to a feeding cup, and to put the tube into the mouth beyond the last molar tooth, unless there is a gap in the front part of the mouth, where a tooth has been lost, through which the tube can be very conveniently passed.

The various methods that have been employed to maintain the broken fragments in their proper position can be classified under four principal methods, viz. bandaging, splints, ligature of teeth, and wiring of the fragments.

(1) *Bandages.*—In simple uncomplicated fractures a four-tailed bandage is generally sufficient to keep the fragments at rest and in apposition. It is made by taking a piece of strong calico or other bandage, one yard in length and four inches in width, with a small slit in the centre for the chin to rest in. Each end of the bandage is cut up to within three inches of the centre of the slit. Having placed the slit over the chin, the two lower portions of the bandage are tied over the vertex, and the two upper ones well above the occipital protuberance. To prevent slipping they may be tied together. In fractures of the lower jaw union is rapid, and towards the end of the third week slight movement may often be allowed; but no mastication should be permitted until the beginning of the sixth week.

(2) *Splints.*—A large number of splints have been devised to keep the fragments in proper position. Of the external splints the gutta-percha trough is often employed. The objection to this splint is that it may serve as a reservoir for the decomposing discharges and saliva from the mouth. When employed it must be cleansed and readjusted frequently. It is made by taking a piece of gutta percha, about three inches broad, and of sufficient length to extend from the angle of the jaw on one side to that on the opposite side, and by bisecting it to within three inches of the centre on each side. By immersion in hot water, so as to make it soft, it is bent into the shape and accurately fitted to the jaw. A hole is cut to receive the chin. It is then lined with boracic lint and kept in position by a four-tailed bandage. There are various forms of external splints which it is not necessary to describe. There are various forms of splints used within the mouth, and among the best of these is the *inter-dental wire splint*, or some modification of it, devised by Hammond. Although this method is so excellent, it is never likely to be largely used by surgeons unless the assistance of a dentist is obtained; because, in order to make a

successful wire splint, a considerable practical acquaintance with mechanical dentistry is necessary. The method may be best described by dividing it into five stages:—

Stage 1. The teeth must be thoroughly cleansed of all tartar. Any decayed focus cleared out and the cavity temporarily filled. The mouth must be free from mucus and saliva as much as possible and washed out with a suitable lotion.

Stage 2. A wax impression is then taken of the teeth with the fragments replaced in their normal position.

Stage 3. A plaster-of-Paris cast is made from this wax impression.

Stage 4. The piece of iron wire is placed around the row of teeth. At first in front of the row, then bending it round the last molar tooth on each side, and taking it round the back of the row of teeth, and then soldering the two ends of the wire together. Great attention must be paid to bending and hammering the wire so that it fits correctly the line of teeth.

Stage 5. The wire frame is now removed from the plaster cast and placed in the mouth. It is necessary to make quite sure that the deformity is completely reduced and that the "bite" of the mouth is correct. Several pieces of thin, soft, iron wire are then passed between the teeth and made to surround them. Numerous inter-dental splints have been devised, but for the surgeon none of them are so satisfactory as the one described. Some splints have been devised partly internal and partly external. They do not merit our attention.

(3) *Ligature of Teeth.*—The fragments are fixed together by tying either silk or wire round the teeth on each side of the fracture. This method has two grave objections: one, that the mobility of the fracture is by no means satisfactorily controlled; the other, that the teeth round which the ligature is passed may become loose and the adjacent gum may become inflamed.

(4) *Wiring of Fragments.*—The best method is that described by Thomas of Liverpool. It consists in drilling the fragments below the tooth sockets, and then passing a piece of stout copper wire through the drilled holes and bringing the fragments together by coiling the copper wire upon a special "key" made for the purpose. During the treatment the wire can be tightened from time to time.

NON-UNITED FRACTURE OF THE LOWER JAW

This is a very unusual condition. Union is often delayed by unusual mobility or by the presence of a tooth between the fragments, but sooner or later union takes place as soon as these antagonistic agents are removed. Again, union by fibrous tissue and the formation of a false joint is a very rare occurrence. The treatment of this condition differs in no respect from that employed in the treatment of ununited fractures generally.

INFLAMMATORY DISEASES OF THE JAWS AND ITS RESULTS

PERIOSTITIS, ABSCESS, AND NECROSIS.—One of the subjects that has led to as much difference of opinion in the past as any in the domain of surgery is the question whether suppurative inflammation of the lower jaw originates in the bone itself or in its periosteum, or whether the trouble always commences in a decayed tooth or its alveolar dental periosteum, and that the main structure of the jaw is infected from this local site. There seems no reason to doubt that acute infective osteo-myelitis or periostitis, which may occur in almost any bone during childhood or adolescence, may occur also in the lower jaw. This, however, is very rarely met. Many surgeons used to maintain that certain children were very prone to a form of suppurative osteo-myelitis and periostitis which often led to loss of the teeth and necrosis of the whole or part of the jaws, especially the mandible. Inasmuch as the children specially affected with this disease presented tuberculous lesions of various kinds, it was termed scrofulous osteo-myelitis. Further, it was stated that in the acute specific diseases of childhood, and in typhoid and typhus fever, a suppurative osteomyelitis could originate by a specific poison itself lodging in the structures of the jaws. This same theory was held regarding inflammation following the inhalation of phosphorous fumes and following the taking of mercury as a drug.

It is now practically established that in all these cases the general disease is only a predisposing cause which weakens the resistance of the gingival mucous membrane or of the teeth, so that ordinary suppurative organisms more readily gain access, and therefore the true cause of all these suppurative inflammations is a local infection by some pyogenic organism present in the mouth.

A short consideration of the anatomical relations of the teeth and jaws shows us how intimate and important is the relationship between them. Between each tooth and the jaw, lining the tooth socket, is a layer of tissue, frequently termed alveolar or alveolo-dental periosteum. It is in this periosteum, situated between the teeth and the lower jaw, that the large majority of inflammatory affections of the jaw commence. According to Miller of Berlin, many facts favour the supposition that a considerable number of pathogenic micro-organisms may thrive in the juices of the mouth without showing any difference from the common parasites of the oral cavity so long as the mucous membrane remains intact. If, however, the soft tissues have been wounded, as in extraction, or if the resistance of the mucous membrane has become impaired, these organisms may gain a point of entrance, and thus become able to manifest their special actions. The severe injuries of the soft tissues of the bone caused by difficult extractions, as well as the open wound left by every extraction, furnish a convenient point of entrance for bacteria. Whoever has examined an unclean mouth, with its broken down teeth, inflamed gums, thick smeary deposits with which some of the teeth are wholly covered, will not wonder that inflammation, suppuration, necrosis, or even pyæmia may follow upon operations in the mouth, and where the typical pyogenic micro-organisms, such as the staphylococcus aureus, etc., are present, we must expect severe suppurative inflammation and formation of abcesses. It is well recognised that the mucous membrane of the mouth may, under certain conditions, become less resistent to the influence of germs, and this may be brought about by mechanical, chemical, or thermal conditions, local or general, so that the nature of the tissues is so changed that a suitable nidus for the development of certain microbes is formed. In some cases the alveolar periosteum of all the teeth is affected simultaneously, whereas in other cases the periosteum of only one or two teeth may be affected; hence we may divide the cases into two classes, the diffused and the localised.

(A.) *Diffused Inflammation of the Alveolar Periosteum.—Etiology and Pathology.*—(1) One of the most common causes of this diffused periostitis was at one time very often met with in persons exposed to the fumes of phosphorus, the disease being popularly called "phossy jaw." From time to time outbreaks of this disease occur in some of the match manufactories.

As this is perhaps the most typical kind of diffused periostitis of the jaw, it would be taken as a type in discussing the various aspects of the disease. A condition very similar to this may be brought about by the administration of mercury in doses large enough to produce a salivation, and other metallic poisons have produced similar effects.

(2) Chronic suppuration may occur at the necks of the teeth, leading to progressive necrosis of the alveolar margin. In this way the fang of the tooth is exposed, and finally the tooth falls out. This condition is termed "pyorrhœa alveolaris" or "Riggs' disease." For a full description of this condition the reader is referred to the article on teeth.

(3) As we have mentioned above, we sometimes see a diffused periostitis, generally of the lower jaw, often leading to extensive necrosis in children of weak vitality. This used to be called strumous periostitis. It is undoubtedly of septic origin.

(4) The severe suppurative inflammation that is frequently associated with the eruption of an over-crowded or misplaced wisdom tooth is probably due to some pathogenic organism reaching the site of the tooth. Unless treated early the inflammation may spread widely and lead to extensive necrosis of the bone. As a typical example of diffused suppurative periostitis of the lower jaw, we will consider the subject of so-called *phosphorous necrosis* or *phossy jaw.* The term necrosis is used because extensive death of the bone is a leading feature. It must be understood, however, that this is only a result of a diffused suppurative inflammation.

Etiology and Pathology of "Phossy Jaw."—According to Stockman, in addition to the various stages of caries of the tooth, the condition of the alveolar margin is one of cario-necrosis, with chronic ostitis and periostitis, differing in no respect from the same lesion as seen in other bones from various causes. It has long been held that this cario-necrosis is due to a septic action of phosphorous fumes on the bone, this being supposed to cause a peculiar and special kind of inflammation. If one considers, however, the whole circumstances and the clinical histories of individual cases, we must definitely conclude that the process is due to the activity of micro-organisms. Phosphorous fumes consist of phosphorous anhydride (p. 406) to a large extent, with some phosphoric anhydride together with some hydrogen peroxide in small traces. It is practically impossible for any of these bodies to produce the extensive mischief so characteristic of phossy jaw. Stockman, from cultivations of pus from several cases, found staphylococcus, albus, streptococcus, and numerous other organisms. He is of opinion that none of these could reasonably be regarded as the cause of cario-necrosis, and inasmuch as he found tubercle baccilli in every case he considers this as amounting to almost proof positive that the disease is of tuberculous origin. He considered that the acid fumes penetrated to the bone directly through the aperture left by a decayed or extracted tooth, that they erode the bone, weaken its nutrition and resisting power, and so make it a suitable nidus for the growth of tubercle bacilli. The bacilli having once started growing, gradually spread according to the ordinary rules of tuberculous infection. The majority of observers, however, consider that the trouble is due to pyogenic organisms, and that the tubercle bacilli are only there by accident, being taken in with the food.

In the very excellent report to the Secretary of State for the Home Department drawn up by Dr. George Cunningham, the opinions of Dr. Stewart upon the subject of phosphorous poisoning are mentioned, and the correctness of his views are confirmed by Cunningham's experience. Although Stewart admits the fact that a caries of the tooth is the commonest point of origin of phosphorous necrosis, yet he points out that the disease may commence in cases where there are no decayed teeth, but in which there are masses of tartar around the tooth at the junction with the gums. As the tartar swarms with organisms it is obvious that the subjacent disintegrating gum may become the point of entrance of the pyogenic germs.

Symptoms.—The earliest symptom is an uneasy sensation in the teeth, which gradually becomes worse until pressure upon them elicits marked pain, sometimes of an excruciating character. This pain is often worse at night, as many other pains are liable to be. The inflammatory trouble develops, and the gums, swollen and œdematous, and the adjacent tissue of the cheek become involved, so that there may be swelling of the face with more or less redness of the skin. On examining the teeth it is found that these are somewhat raised in their sockets and more or less loose. On examining this stage of the trouble there is very marked salivation, and owing to the pain preventing the patient moving the muscles of the tongue and mouth effectively, there may be dribbling of saliva. By very careful and thorough treatment at this stage the disease may subside. As a rule, however, matters are neglected; the inflammation spreads to the general periosteum of a greater or less extent of the jaw. In this way the nutrition of the bone suffers, and finally more or less of it becomes necrosed. The pus may burrow towards the cheek or down into the neck; and if neglected, numerous sinuses may form, and these persist until the dead bone is removed.

Treatment.—Stockman states that as regards prophylaxis there is absolutely no risk of inflammation as long as the bone remains protected by gum, and even when carious teeth are present the entrance of the organisms can be prevented by careful stopping. Efficient ventilation of the workshops will prevent the acid fumes arising from the phosphorus and make them less active in injuring exposed bone. Assuming that the affection is due to the tubercle bacillus, the matter is then quite apart from the factories and cannot be controlled at present either by State regulations or workshop rules. It is acquired, as other tuberculous affections are acquired, by certain persons and not by others; and, owing to the wide distribution of the organism, persons with exposed bone, eroded by acid fumes, are very apt to become infected. Every attention must be paid to the cleaning and scaling of the teeth, so that no tartar becomes deposited on them; all decayed teeth must be cleaned out and stopped, and great attention paid to the cleanliness of the mouth generally. In the early stages of the disease it is advisable to get the mouth as clean as possible by using antiseptic mouth-washes every half-hour or so. Local complications round the neck of the tooth, such as tincture of aconite or of pyrethrum, seems to lessen the inflammatory reaction. The gums must be carefully watched for the formation of any collection of pus under them, and as soon as this is detected it must be incised and washed out. The effort of the surgeon must be directed especially to prevent the accumulation of pus in any part of the mouth. In this way any extensive necrosis can be readily prevented. When necrosis has once formed, the region must be kept as clean as possible, and as soon as the dead fragment is separated from the living it must be removed.

B. *Localised Suppurative Periostitis.*—Under this heading we have the very common trouble known as *alveolar abscess*. Owing to the way in which the pus may burrow in neglected cases, the alveolar abscess has considerable interest, and therefore must be considered in this article as well as in the article on Diseases of the Teeth.

Etiology and Pathology.—This probably always originates by the introduction of micro-organisms through some decayed focus in the tooth or some abrasion of the gum at the neck of the tooth. It is stated that in some cases an abscess appears to rise without any morbid condition of the teeth or gum; but this is probably a mistake, as a very careful search would probably lead to the discovery of the point of entrance. It must be remembered that slight abrasion of the gum at the neck of the tooth which may have allowed the organisms to enter may have healed up subsequently, and so concealed the point of entrance. According to Tomes, as the disease progresses the periosteum becomes detached from the cementum, and the point of suppuration usually commences at and extends from the foramen in the root of the tooth, and as the pus forms in greater and greater amount, the fang gradually loses its vitality and the pus gradually causes dilatation of the socket. As soon as the tension exercised by the presence of the pus reaches a certain degree the pus finds its way to the surface. One of the most common ways is for the pus to find its way up the side of the tooth, between it and the socket, reaching the surface at the edge of the gum either on the inner or outer side of the tooth, thus forming the ordinary gum-boil. As a rule the pus pierces the gum within the mouth. In the case of the upper incisor teeth, however, the pus tends to burrow between the periosteum of the hard palate and the bone, thus forming a palatal abscess. When the upper incisor teeth are decayed the abscess may point within the nostrils. An abscess in connection with the molar teeth of the upper jaw may point on the surface of the face above the reflection of the buccal mucous membrane. In other cases the pus may burst into the antrum of Highmore. In the case of the lower jaw the pus may find its way on to the face near the lower margin of the jaw; and, in the case of the molar teeth, the pus may burrow down into the neck and have to be opened even below the cavicle.

Symptoms.—At first there is a dull sensation familiar to most people scarcely worthy of the name of pain. At this early stage the uneasiness or pain may be removed by biting upon the teeth. As the trouble progresses there is a dull aching pain and the tooth is slightly raised from its socket. The pain soon becomes more and more acute and throbbing in character, and the constitutional symptoms become very severe, accompanied by a high temperature. In addition to the swelling of the gum in the region of the tooth the œdema may spread to the soft tissues of the face and cause marked swelling there. There is very often sudden relief to the pain when the pus finds its way out of the tooth socket, because it is then collecting at considerably lower pressure. It is this sudden improvement in the pain that may lead the medical attendant to think that the abscess has subsided, whereas the pus may be forming in large quantities under the gum or in the tissues of the face.

Complications.—Although alveolar abscess, even if untreated, may subside spontaneously as soon as the pus reaches the surface, yet occasionally very grave symptoms may follow, such as pyæmia. A spreading cellulitis may develop, spreading rapidly in the tissues of the face and neck. In some cases the pus spreads widely under the gum and separates a large part of the lower jaw, causing considerable necrosis. Inflammation of the lymphatic glands under the jaw is practically always present, but only occasionally does suppuration occur in them.

Treatment.—The early treatment belongs to the domain of the dentist. Before any large amount of inflammatory exudation has formed it may be able to evacuate it by removing the septic focus and reaching the inflamed area. For this treatment the reader is referred to the article on Teeth. As soon as the pus leaves the tooth socket it can be recognised readily by the way in which the gum is raised up and stretched. As soon as this is recognised an incision should be made with a scalpel right through the swollen gum. As a rule, by careful treatment a tooth may be saved if it is worth saving. Many good teeth are sacrificed by the dentist or surgeon not having the requisite knowledge to know whether teeth can be saved or not.

Necrosis.—It must be clearly understood that necrosis does not in itself constitute a disease, but is the result of a previous suppurative inflammation of the bone or its periosteum. For certain reasons the lower jaw is more commonly the seat of necrosis than the upper jaw. It is common to speak of various forms of necrosis. The differences are really due to the cause of the suppuration rather than to any difference in the final result. They may be classed as follows:—

(1) Necrosis of the alveolar process due to suppuration in the apex of the tooth and the alveolar dental periosteum. This may spread to the main structure of the lower jaw and cause more or less extensive necrosis. In other words, the necrosis is a result of alveolar abscess.

(2) The suppuration that may result from an overcrowded or misplaced wisdom tooth may lead to extensive necrosis, as already mentioned.

(3) Necrosis following diffused suppurative periostitis, of which the chief example is, as we have seen, phosphorous necrosis. Under this heading should be placed the necrosis following the administration of mercury and other drugs. Under this heading should also be placed the diffused suppurative periostitis occurring in the course of certain septic fevers.

(4) Necrosis may follow any extensive injury to the jaw, especially comminuted fractures. Necrosis may occur owing to some laceration of the tissues of the mouth spreading to the periosteum and bone, as in the case of cancrum oris or any malignant growths.

(5) Necrosis may occur as the result of syphilis, as we shall see later.

(6) Necrosis may also occur as a result of tubercle, apart from any action tubercle may have in the causation of phosphorous necrosis.

The treatment of the various forms of necrosis differs in no way from that of necrosis of bone generally, and need not detain us here.

Dislocation of the Lower Jaw.—In the great majority of cases the immediate cause has been muscular action alone, such as yawning, vomiting, etc. It may be due to direct violence, such as a blow or a kick of a horse. A force acting from within the mouth may also produce dislocation, *e.g.* the introduction of an apple or billiard ball into the mouth, extraction of teeth has been known to cause dislocation of the jaw. Bilateral dislocation of the jaw is more common than unilateral. The exact mechanism of dislocation has been much discussed. As the jaw is depressed the condyle glides forwards on to the articular eminence, and as soon as it is in this position a comparatively small force is sufficient to drive the condyle forwards over the eminence and thus produces a dislocation. As a rule the ligaments of the joint are not torn, but apparently in severe cases both the synovial membrane and the external ligament may be torn. As soon as the condyles are dislocated, the masseter and internal pterygoid muscles contract and draw the jaw forwards and upwards. It is the action of these muscles, in all probability, that causes fixation of the coronoid process beneath the malar bone. It has been maintained, however, that the coronoid process actually catches against the malar bone. It is quite possible that in certain cases where the malar bone is well developed and the coronoid process is large that this may occur.

Symptoms.—In a recent dislocation the deformity is as a rule very evident. The mouth is open and the jaw is fixed. Speech and swallowing are much interfered with because the lips cannot be properly approximated, and the saliva dribbles from the mouth. On examining the neighbourhood of the joint a depression will be seen and felt immediately in front of the ear, and in front of this the displaced condyle may be seen and felt. The coronoid process can also be felt just below the malar bone. In unilateral dislocation there is inclination of the chin away from the dislocated side. On comparing the joint on the two sides the dislocated one can be readily distinguished.

Long-Standing Dislocations.—At one time this seemed to have been a fairly common occurrence. The patient has not consulted a doctor at the time, and gradually the jaw has obtained a certain degree of mobility so that the lips can be closed, and in this way both speech and swallowing may be little if at all impaired. The alteration in the patient's appearance would not be so noticeable to a doctor who had not seen the patient before.

Recurring Dislocation.—Sometimes there is a great tendency for the dislocation to recur. It may be quite frequently an act of yawning, etc., which may produce it.

Dislocation of Inter-Articular Fibro-Cartilage.—A case of this kind has been described where there is dribbling of saliva and enlargement of the left submaxillary gland. This latter may have been due to injury of the corda tympani nerve.

Treatment.—The simplest method is for an assistant to grasp the head of the patient firmly against his chest, while the surgeon, with his thumbs projecting, presses them as far back as possible upon the lower molar teeth, at the same time grasping the body of the jaw with his fingers. Firm pressure is then exerted by the thumbs in a direction downwards and backwards so as to free the condyles from the articular eminence, and as soon as this is done the chin is raised by the fingers. Various apparatus have been described for forcing the jaw downwards.

Long-Standing Dislocations.—These are usually fairly easily reduced within the first two months. The longest period that has elapsed, and in which successful reduction has been obtained, is about ten months. If manipulation fails to reduce the dislocation the condyle should be cut down upon and replaced with as little cutting of ligaments or muscle as possible.

Recurring Dislocation.—The patient should be cautioned against opening the mouth at all widely. If yawning cannot be prevented the chin should be well supported during the act. If dislocation occurs very frequently and easily an elastic bandage might be fitted to support the chin. In other cases the jaw may be kept absolutely immobile for a long period of time. Operative treatment has been considered necessary. The joint has been cut down upon and the fibro-cartilage stitched to the external ligament near its attachment to the bone.

Parasitic Diseases of the Jaw

The fungus mycosis aspergilla has been found in the antrum of Highmore, and a curious form of distoma (fasciola hepatica) has been found in the pus escaping from an extensive alveolar abscess. These are quite surgical curiosities. A very important parasitic disease is *actinomycosis*. This disease usually occurs primarily in the jaws; mandible more frequently than the maxilla. It may, however, occur primarily in almost any part of the body. It is a disease very commonly met with among cattle. The active agent is a fungus termed actinomyces, sometimes called the ray-fungus, from its characteristic appearance under the microscope. The fungus is taken in with the food, and may lodge in any part of the alimentary or respiratory tracts. The jaws, however, are the structures which seem especially prone to this disease, and the explanation is owing to the intimate relation that exists between the teeth and the jaws. During mastication the fungus is driven into some decaying focus in a tooth. Here it remains undisturbed, and gradually penetrates into the bone.

Symptoms.—The earliest symptom is very often tenderness, and sometimes severe pain localised to one or more of the teeth, and on examination the affected teeth are found to be carious. This pain is generally attributed to ordinary decay of teeth—indeed, it would be impossible at that stage to ascertain whether actinomyces is present or not. Within a few weeks a swelling forms; in the case of the lower jaw it is usually situated in the region of the angle; when the upper jaw is affected the swelling is usually noticed at some part of the cheek. On manipulation it is found that the swelling is firmly fixed to the jaw, and it may be either soft or hard. As the tumour increases in size the skin over it becomes red, rather tense, and finally fluctuation can be detected. If neglected, this swelling will ultimately burst, and a turbid, serous liquid escapes which contains in suspension small yellow granules. These are very characteristic in appearance, and consist of masses of fungus. The septic process that accompanies the growth of this fungus tends to become widely diffused, and various fistulæ form communicating one with the other, and opening on the surface by numerous apertures sometimes quite crateriform in appearance. On probing the sinuses bone can readily be felt. The submaxillary lymphatic glands become enlarged, and may suppurate so that sinuses of various extent may be present in the neck. If the inflammation progresses towards the ramus of the jaw it may interfere with the movements, and a condition known as "closure of the jaw" is produced. In slow-forming cases there is little or no temperature, but if the associated septic process is marked a somewhat hectic temperature may be present. Owing to the chronic discharge of pus we may have the usual changes associated with this condition. As a rule the course of the disease is chronic, lasting one or two years; it may, however, be very rapid and terminate fatally within three months.

Prognosis.—Early eradication of the disease is the only hope for the patient. If the disease has been allowed to progress extensively the patient becomes emaciated, and is very liable to fatal complications, especially of the respiratory organs. Secondary foci of the disease may appear in various organs, especially the lungs. The prognosis appears to be very serious when the upper jaw is affected. In rare cases the disease has been cured by merely incising and draining the tumour. Cases have been reported where surgical treatment has cured the trouble. If secondary foci have formed in the viscera the prognosis is probably hopeless.

Diagnosis.—If the characteristic yellow granules can be found the diagnosis is at once made certain. Sometimes, however, these may not be found even after a most careful search. In such cases the diagnosis may be most difficult. Similar sinuses of a chronic nature may be caused by syphilis or tubercle, or some form of necrosis of the jaw, which may simulate very closely the appearance caused by actinomycosis. It is important to ascertain the occupation because so many of the persons affected have been associated with cattle in their daily work.

Treatment.—Complete removal of the fungus should be attempted. A very free opening of the sinuses and scraping away of all broken down tissue is imperative. Diseased portions of skin should be freely removed with a knife. Indeed, the more extensive and energetic the treatment with the knife the more favourable the prognosis. The injection of germicides, such as perchloride of mercury, should only be undertaken when the patient refuses operative interference.

Tuberculous Disease of the Jaw

Tuberculous disease of the gums may occur. It is nearly always found when the patient has active pulmonary tubercle as well. There seems little doubt that the expectorated bacilli effected a lodgment in some abrasion of the gum. If the bone is affected it is due to a spread of the disease from the gum, which is the primary seat of infection. Tuberculous disease occurring primarily in the jaws is met with, but is, comparatively speaking, rare. It is found sometimes on the surface of the superior maxilla in the region of the malar process of the maxilla. In the case of the mandible it usually occurs along the lower border of the body and in the region of the chin. The symptoms and course of the disease differ in no way from tubercle in other parts of the body.

Syphilitic Affections of the Jaws

Primary chancres of the gums have been met with; the most probable cause of infection is by the forceps used by a dentist in extracting a tooth. As regards the tertiary manifestations of syphilis gummata, both localised and diffused may occur in both jaws. The disease may lead to various thickenings and exostosis especially in the lower jaw. The manifestations of syphilis here do not differ from those in other parts of the body.

Tumours of the Jaw

It is a difficult question to decide upon the best method of classifying tumours of the jaws. Quite a simple method, apparently, is to divide them into simple and malignant. Experience teaches, however, that no sharp line of demarcation can be drawn between these two classes of tumour. A growth, apparently simple in nature, may suddenly and rapidly develop malignant properties. Of course it will be argued that this growth was from the first malignant, but that the infective tendency was held in check for a long time until certain conditions unknown to us became favourable for its growth. This argument, of course, shows how difficult such a classification becomes.

There is one large group of tumours having one point in common, namely, that they apparently originate in some part of a tooth during its development. These tumours are termed *odontomata*. At first the term was restricted to certain hard tumours composed of enamel or dentine or cementum, or of a combination in varying proportions of any of these three elements. Subsequent researches, however, have shown that numerous other tumours, especially of a cystic nature, originate during the development of a tooth, and therefore a wider definition of odontoma is advisable. According to Bland Sutton, odontomata are neoplasms composed of dental tissue (namely dentine and cementum) in varying proportions and different degrees of development arising from tooth-germs or teeth still in the process of growth. In order to thoroughly appreciate the nature of this large group of odontomata the reader must bear in mind the chief points in the development of a tooth. About the seventh week of intra-uterine life the epithelium of the gum begins to grow rather rapidly along the alveolar border, and from the Malpighian layer masses of epithelium grow down into the subjacent tissue. This downgrowth of epithelium is termed the *common enamel germ.* As development proceeds the changes in the common enamel germ become localised to certain spots where the teeth are eventually developed. At these spots the epithelium grows down in the form of flasked-shaped bodies termed the special enamel germs, and these two are connected by a narrow band of epithelial cells forming the neck of the enamel germ or funicular band. Coincident with these changes in the epithelium we find that the underlying connective tissue becomes divided into twenty papillæ. Each papilla projects upwards and forms a dent in each enamel germ. From these papillæ are developed the pulp, the dentine, and the cementum, and hence it is termed the *dental papilla.* The soft connective tissue round the papilla and the enamel germ forms a kind of capsule, and a whole structure, namely, the enamel organ, the dental papilla, and the fibrous capsule, is termed a dental follicle. While the development of the milk teeth is progressing we find that the first rudiments of some of the permanent teeth appear, namely, those of the permanent teeth which actually replace the milk teeth. About the sixteenth week a small downgrowth of epithelium grows from the funicular band above described, and develops into the enamel organ of the corresponding permanent teeth. From the funicular band of these permanent teeth another downgrowth of epithelium may occur. In the human subject this rarely forms a tooth, but represents the rudimentary third dentition. It will be seen from this description that some of the epithelium cells that grow down do not persist, and form any definite structure. It used to be assumed that these cells simply atrophied. It seems, however, that they persist and may be found in the adult jaw in three groups. There are various tumours which seem to be formed from some portion or other of the dental follicle, or from the apparently useless masses of epithelium cells above described. They may be classified as follows:—

1. *Follicular Odontomes.*—Under this heading three kinds of cysts may be described.

(*a*) *Dental cysts* which contain neither a tooth nor the rudiment of a tooth. They are met with more frequently in the upper than in the lower jaw, and generally in connection with the incisor or canine teeth. They may grow to a large size, and produce more or less absorption of the outer wall of the maxilla.

(*b*) *Dentigerous cysts,* which contain one or more teeth in their interior or in their wall. The teeth may be well formed or may be quite rudimentary, consisting of irregular masses of bone and enamel.

(*c*) *Multilocular Cysts.*—There is considerable difference of opinion upon the nature of these cysts, but in all probability they originate in connection with some part of the dental follicle.

2. *Epithelial Odontomes.*—These probably originate from some of the bands of epithelial cells above described. According to Bland Sutton they occur most frequently about the twentieth year. They are encapsuled at first; when the overlying mucous membrane ulcerates the capsule is destroyed, and they may then resemble epithelioma. If left they erode and destroy the surrounding bone.

3. *Radicular Odontomes.*—This term is applied by Bland Sutton to odontomes which arise after the crown of the tooth has been completed, and while the roots are in the process of formation. As the crown of the

tooth is completed in development the resulting odontome is devoid of any enamel, and consists either of dentine alone, or of cementum, or of a combination of both.

4. *Composite Odontomes.*—Bland Sutton defines these as consisting of hard tooth tumours which bear little or no resemblance in shape to teeth, but consist of a conglomeration of enamel, dentine, and cementum.

Tumours of the Jaws.—Both the upper and lower jaws are the seats of tumours of the ordinary kinds such as are met with in other parts of the skeleton. They form naturally into two growths, the simple and the malignant. The description will apply equally well to whichever jaw is affected.

There are three well-recognised non-malignant tumours in the jaws.

1. *Fibroma.*—This closely resembles fibromata occurring elsewhere. It nearly always occurs in the region of the alveolus. When arising from the alveolus adjacent to the antrum it may project into that cavity and appear to be growing in it. These fibromata are considered by Bland Sutton to be of the same origin as the odontomes. Some people consider that they may result from chronic inflammation around the apex of a tooth. They are easily removed.

2. *Enchondroma* of the upper jaw is rare. Cartilaginous tumours are much more common originating in other bones of the face. If allowed to progress they may reach an enormous size. They easily shell out and do not recur.

3. *Osteoma.*—Various bony outgrowths of the jaws occur. It has already been mentioned that they may occur as a result of syphilis. It may be convenient here to mention the remarkable disease known as *leontiasis ossea.* This disease causes an extraordinary thickening of the bones of the skull and the jaws, to which it is generally confined. It is especially prone to affect the superior maxillæ, but it also affects the lower jaw. All parts of the bone are thick and dense, and outgrowths from the bone project into and obliterate all the air spaces of the skull. The antrum is usually obliterated, the nasal fossæ are blocked up, the orbits are encroached upon, and the eyeballs displaced. The disease appears during childhood and progresses very slowly; the first indication of deformity is usually in the protuberant masses from the maxillæ forming a swelling in each cheek. It is suggested that it may be some form of rickets. No curative treatment is known. Any protuberance may be chiselled off if thought advisable. (See also "Leontiasis ossea," vol. vi.) We may here mention the fact that *acromegaly* is a disease which specially affects the superior maxilla as well as other bones of the body. For a full description of the disease see vol. i.

Malignant Tumours.—Two malignant growths occur in the jaws, sarcoma and carcinoma, the former being much more common.

Sarcoma.—This is the only malignant growth which commences in the substance of the jaw itself. It seems to originate in two ways, either in the bone itself, when it is termed central sarcoma, or in the periosteum, when it is termed peripheral or periosteal sarcoma. The central growths are often myeloid sarcoma.

Carcinoma.—In the upper jaw carcinoma appears in two forms, one which probably always begins in the gum or palate, and is composed of squamous epithelium. This was considered when dealing with diseases of the gums, see p. 150. The other variety is columnar epithelioma, which always begins in the antrum; see diseases of antrum, article "Nose."

Operations on the Jaws.—Operations upon the jaws are nearly always performed for the removal of growths, and therefore many of the operations can scarcely be of a formal character, but the surgeon must plan his incisions according to the exact relations of the growth. In this place, therefore, it will be necessary simply to describe the formal operation for excision of the jaws.

Excision of the Upper Jaw.—The method usually practised is Ferguson's modification of Liston's method. An incision is made through the centre of the upper lip to the columella, then transversely at the posterior margin of the anterior nares, and round the alæ of the nose up to a point just below the inner canthus, then outwards along the lower margin of the orbit to just below the outer canthus. This flap is reflected outwards, all the soft tissues down to the bone being removed. With a suitable saw the malar bone is sawn through in a line with the spheno-maxillary fissure, then the nasal process of the superior maxilla is sawn through, and finally the saw is placed through the nostril and the hard palate and alveolus are divided. Just before this last saw-cut is made the central incisor of the maxilla to be removed is extracted, and the mucous membrane over the hard palate is divided with a knife along the line where the saw is to emerge. As soon as the saw-cuts have been made, the soft palate is separated from the hard palate by means of a scalpel, and this transverse incision is carried outwards around the tuberosity of the maxilla. The bone is then seized in a pair of lion forceps and forcibly pulled downwards and forwards, any soft tissue being divided that is necessary. When possible the orbital plate should be left, so that the eyeball does not suffer to any extent. When the orbital plate is removed there is great tendency for the eyeball to drop, and for the patient to get diplopia and other troubles.

In order to prevent deformity many methods have of recent years been devised, and these will be considered after removal of the lower jaw has been described.

Excision of Lower Jaw.—A skin incision is made from the point just to one side of the middle line running along the lower border of the jaw as far as its angle, and then upwards along the posterior border of the ramus to a point just below the lobule of the ear. The tissues are cut right down to the bone, and the soft tissues are separated, first on the outer side right up to the reflection of the mucous membrane of the mouth, and then on the inner side dividing the mylo-hyoid, internal pterygoid, etc. The central incisor of that side is then removed, and the mucous membrane of the mouth divided after all hæmorrhage has been stopped. The jaw is then held firmly in a pair of lion forceps, and is cut through between the central and lateral incisor teeth, so as to leave the attachments of the tongue. As soon as the jaw is divided it is pulled forcibly downwards, and the knife is carefully turned upwards to divide the attachment of the temporal muscle from the coronoid process. The external lateral ligament is then divided and the jaw forcibly pulled downwards, so that the external pterygoid muscle is torn through and not cut. Provided the jaw is pulled directly downwards and not twisted there is no danger of wounding the internal maxillary artery, but any attempt to cut the external pterygoid with a knife would involve wounding of that vessel. Further, by twisting the jaw at this stage the internal maxillary artery may slip over the condyle and be torn as the jaw is pulled away. Some surgeons prefer to divide the coronoid process with a saw and then to remove the small piece of bone afterwards.

Immediate Prosthesis.—After removal of the jaws there is of necessity a considerable amount of deformity, especially in the case of the lower jaw. In the latter case also the remaining portion of jaw becomes pulled out of its proper position, and so mastication is rendered impossible. Of recent years attempts have been made to do away with this great reproach against operations on the jaws. For the advance of our knowledge in this direction we are chiefly indebted to certain French dentists, especially MM. Preterre, Claud Martin and Michaels. The principle of the method adopted by Preterre and Claud Martin is to insert a mechanical contrivance into the mouth directly after the jaw is removed, so that the scar tissue which forms as the wound heals is prevented from dragging the remaining portions of the jaw out of their proper position. When the wound has sufficiently healed this temporary structure is removed, and in its place a permanent apparatus bearing teeth is inserted. There are thus two stages in this method: the immediate or temporary prosthesis, and the secondary or permanent prosthesis. The temporary apparatus employed by Claud Martin is extremely ingenious and requires a high degree of mechanical dental experience. In his hands it has given excellent results, but the method is too complicated and costly for general use, and in this country but little if any work has been done in this direction. Michaels has attempted to attain the object with one apparatus which is designed to remain in position and to become surrounded by the healing tissues. Broadly speaking it consists of a metal support which is fixed as much as possible to bone. It is usually made of gold, and becoming surrounded by granulation tissue, it remains buried in the deep part of the wound. In the case of the lower jaw various modifications of this method have been tried. For instance, in order to fill in a gap where a tumour had been removed from the body of the jaw, leaving an interval of about two and a half inches, Stanley Boyd fixed a piece of knitting needle between the two fragments, and this became embedded and kept the two remaining portions of the jaw in their proper position. The writer has tried Michaels' method in the case of the upper jaw without success, but has been successful in the case of the lower jaw, although a part of the apparatus came away in each case. The position of the fragments remained perfect.

Diseases of the Temporo-Maxillary Joint.—Acute Arthritis.—These cases fall naturally into two groups:—

1. Non-suppurative arthritis caused by rheumatism, injury, and gonorrhœa. There is swelling and pain in the region of the joint, and usually an irritating pain in the temple or ear. There is difficulty or impossibility of opening the mouth. It may last from one to three weeks, and sometimes terminates in partial or complete ankylosis.

2. *Suppurative Arthritis.*—This nearly always occurs during the course of some specific febrile disease such as scarlet fever. Some cases, however, are secondary to suppuration in the middle ear. As soon as the nature of the disease is recognised an incision should be made on the outer side of the joint and the pus evacuated. It is very liable to be followed by ankylosis.

Chronic Arthritis.—Like osteo-arthritis of other joints this is prone to occur in advanced life, although it is not one of the joints that is commonly affected. The inter-articular fibro-cartilage is gradually worn away. The ordinary changes take place in the bony parts of the joint, and finally there may be almost complete ankylosis. A not uncommon symptom of this disease is a partial dislocation which only occurs when the mouth is widely opened. It is termed "subluxation" and looked upon as a disease in itself. It seems, however, to be undoubtedly a symptom of a certain stage of osteo-arthritis.

Tuberculous Disease.—This is very rare in the temporo-maxillary joint, and only a few cases are recorded. Its treatment differs in no respect from tubercle of other joints.

Treatment.—The treatment of all forms of disease of the temporo-maxillary joint consists chiefly in obtaining complete rest during the acute and painful stage. In the non-suppurative diseases massage of the muscles and manipulation of the joints should be practised as soon as convenient in order to prevent ankylosis. In the suppurative cases, after the pus has been evacuated, a similar line of treatment should be adopted.

Closure of the Jaw.—By this term is meant a condition in which the mandible cannot be completely depressed, so that the mouth is only partially if at all opened. There is every degree between immobility and almost complete mobility. The classes fall into two groups:—

1. *Spasmodic or Temporary Closure of the Jaw.*—The most common cause is some inflammation of the lower jaw, such as mumps, inflammation of lymphatic glands, etc. The trouble may be in the jaw itself, especially in cases of impeded eruption of the wisdom teeth. It has also been met with as a symptom of some disease affecting the nervous system, such as tetanus. It is sometimes met with as a symptom of hysteria. As soon as the cause is removed the trouble disappears.

2. *Permanent Closure of the Jaw.*—These fall into main groups. Those resulting from diseases of the joint, and those caused by cicatricial bands within the mouth. In the case of ankylosis of the joint various operations have been devised after all other attempts at obtaining movement have failed. The most successful operation is to remove the condyle, or both condyles if the disease is bilateral. In cases where cicatrices in the mouth are the cause of the trouble, division of the constricting bands should be tried, but this method of treatment often fails as it is impossible to prevent the formation of fresh scars. In such cases Esmarch's operation is sometimes performed. Its principle is to form a false joint in front of the cicatrix. Successful operations of this nature have been performed.

LITERATURE.—Stockman, *Brit. Med. Journ.* 1899, on "Phosphorous Necrosis."

Mucous Membranes.—When we consider the wide diversity in the positions and functions of the different mucous membranes in the body, it is not surprising to find that their diseases occupy a very prominent place in general medicine. The affections of the different mucous tracts are discussed under their appropriate headings. The present note is a general one bearing on the morbid conditions in general. There is probably no subject in medicine which illustrates so well the great advances and progress made in medical science within the last decade or more, this being dependent on the great development of the science of bacteriology. A few years ago we classified the affections of the mucous tracts in some such way as the following:—Injuries, hyperæmia and anæmia, inflammation, ulceration, gangrene, etc., and had a very inadequate idea of the close relationship these may have to each other and to their common causal agents. Our knowledge on these points has advanced much within recent years, but is still far from complete.

A reference to such articles as the "Bronchi," "Intestine," "Nose," "Urethra," and "Vulva" in other parts of this work illustrate where we stand in this matter. It will be noticed that in each of these sections the writer first lays stress on the bacteria which are normally present, and then passes to the consideration of the conditions under which they, or other bacteria, exercise a pathogenic effect. But it is just on this point that our knowledge is yet extremely limited. Take the bacillus coli, for example. It is present in the alimentary tract under perfectly normal conditions. No harm, possibly some good, results from its presence. But see the tremendous importance of that microbe in one of its numerous forms in relation to many of the most serious and fatal suppurative affections in the abdomen and elsewhere. Many interesting and important problems are here raised. What, for instance, is the determining factor in the absorption of that bacillus or its toxines from the digestive tract? Does it depend on the existence of a breach of continuity in the lining membrane of the bowel, or does it depend on some defect in the local secretion, as a result of which the bacillus finds itself in a more favourable nidus for active development? In many instances both of these conditions are doubtless present, but a third important one calls for consideration. This has reference to the question of general relative immunity to the influence of the bacillus. In other words, has the long-continued presence of that microbe as a saprophyte been attended by alterations in the body fluids and tissues of a nature enabling them to withstand the toxic action of the bacillus? (See also "Immunity.") These points are mentioned merely by way of example, and it is unnecessary to amplify them to any extent. These are the important questions that confront the practitioner in cases of bronchitis, cystitis, and the like, and their due appreciation directs to a more rational and successful treatment. It is hardly necessary to refer in detail to the various morbid appearances in these disorders. The important part to remember is that we are dealing with the local reaction to a special irritant, and the nature and severity of the changes in the mucous, submucous, and other coats will depend on the individual power of reaction. In some cases the resulting changes will be more of a hypertrophic, and in others of an atrophic nature. Not infrequently more than one etiological factor has to be considered.

Multiple Sclerosis. *See* PARALYSIS.

Mumps, or Epidemic Parotitis.

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EPIDEMIC parotitis, or, to use the popular and better term, Mumps, is a specific infectious disease which must be distinguished from the "metastatic" parotitis occurring as a sequel to many abdominal affections. Mumps is endemic in most large towns; at times it assumes an epidemic form, and local outbreaks in schools and similar institutions are very frequent. It seems to be more common in this hemisphere than in America. Emmet Holt refers to it as a not very common disease, and says that general epidemics are rare, while other American writers state that a locality may remain free from it for twenty or thirty years. The disease is most frequently met with between the ages of four and fourteen years, but adolescents and adults are also liable to it. The extremes of life, however, are spared, and infants and the aged but seldom suffer. Mumps is extremely contagious, and there is no doubt that the infection may be conveyed, without personal contact with a case, through the intermediary of a third person or by fomites. Epidemics are most common in cold and damp weather, and in the spring and autumn, perhaps because the climatic conditions then prevalent tend to prevent due ventilation of dwelling-houses. Epidemics not infrequently follow outbreaks of measles. Boys are somewhat more liable to be infected than girls, and it is said that mouth-breathers are peculiarly liable to the disease. The incubation period is very variable; it may be as little as three days, but more commonly lies between fourteen and twenty-five days, the average being perhaps seventeen to twenty-one days. The medical officers to school associations recommend twenty-four days' quarantine, dating from the first exposure to infection. One attack of mumps confers a very complete immunity, second attacks being almost unknown; relapses are rare, but may occur. Mumps is a mild disorder, and the mortality is almost nil, though in some epidemics complications are more common than in others. The disease seems to be infectious during the latter part, if not the whole, of the incubation period, and the infectiousness is greatest just before the parotid swelling develops—that is, before a diagnosis can be made. It persists for about three or four weeks from the onset of the symptoms, or until ten or twelve days after all signs of parotid enlargement have disappeared.

Pathology.—While it is, of course, certain that mumps is due to a specific germ, no organism has yet been proved to be the cause of the disease. Pasteur found a bacterium in the blood of patients suffering from mumps, and Bordas and others have described a bacillus parotidis in the blood, saliva, and urine. With more recent and precise methods there is now a consensus of opinion that the disease is due to a diplococcus possessing definite cultural peculiarities, but since the organism has never been successfully inoculated into animals it cannot be regarded as more than the probable infective agent. Netter, Laveran, Cabrin, Mecray, and Walsh have all observed this diplococcus in the blood and in the secretion of the inflamed glands, while they have failed to obtain it in healthy individuals. It grows in pairs or in sets of four, or sometimes as a zooglea. Cabrin and Laveran obtained it in 67 out of 72 cases from the exudation drawn from the gland by a hypodermic needle. It stains with the ordinary aniline dyes, and is decolorised by Gram's method. It grows slowly on agar, more quickly on blood-serum, giving rise to circular whitish colonies; it liquefies gelatine in twelve to fourteen days, and turns litmus milk pink on the third day

The inflammation of the parotid is chiefly interstitial, spreading from the duct and involving the periglandular tissue as well as the gland itself. In the testicle the atrophy results from a parenchymatous rather than an interstitial inflammation; the tubules only are affected, the basement membrane becoming thickened, and the epithelium atrophied.

Symptoms.—In the vast majority of cases occurring in childhood the disease is a very mild one, and gives rise to little discomfort; most of the severe cases occur in adults. Most commonly little is noticed before the parotid swelling appears, but prodromal symptoms may occur. The temperature rises a degree or two about twenty-four hours before the onset of parotitis, and with the initial fever the patient may complain of headache and discomfort. Occasionally there is considerable prostration and delirium; convulsions, even, have been recorded. Attention is first directed to the true nature of the malady by pain and stiffness, with slight tenderness, referred to the angle of the jaw below the ear, most commonly, I think, on the left side. Very soon a swelling can be detected, which goes on until the whole parotid is involved. The enlargement of the gland is considerable, and has a doughy, elastic feel, the skin over it being somewhat tense, but remaining pale, or at most showing a faint blush of red. The outline of the gland is not usually distinct, and one gets the impression that there is a good deal of exudation into the surrounding tissues. The gland on the opposite side becomes similarly affected about twenty-four or thirty-six hours later, and the disease is at its height by the third or fourth day. At this time the appearance of a patient suffering from mumps is quite characteristic: the face looks unduly broad, especially at its lower part, and the somewhat conical shape of the head and neck, when there is much swelling of the neighbouring parts—particularly when the submaxillary and sublingual glands are also affected—gives to the sufferer a slightly ridiculous aspect. When the parotitis is fully developed considerable discomfort is experienced. There is usually a good deal of pain radiating towards the ear; the mouth cannot be opened more than half an inch or so, and chewing, and even swallowing and speaking, are rendered difficult. The head is held stiffly, on account of the pain caused by movements of the neck, and there is general tenderness over the parotid and other salivary glands. As a rule, however, we find that the gland first affected has begun to subside before its neighbour has reached its maximum, and the swelling gradually diminishes, and disappears in from a week to a fortnight of its onset. In most cases there is little constitutional disturbance, the temperature being 99° or 100°; at times it reaches 102° or 103°, but almost always falls rather abruptly to normal a day or two after the parotitis shows itself. There is sometimes slight desquamation of the skin over the affected glands after the swelling subsides.

While the above is a general outline of the course of an ordinary case of mumps, there is such variability in its symptoms, and its possible complications are so numerous, that we must look at them in a little detail. In almost all cases both parotids are affected within a very short interval of time—indeed, this is the sign on which we rely when the diagnosis is doubtful—but sometimes the inflammation remains limited to one side, and sometimes the second parotid is not involved until several days or weeks have elapsed. Again, the submaxillary and sublingual glands do not always become inflamed, while, on the other hand, they alone may be the seats of infection, or they may be enlarged only after the parotid swelling has subsided. There is seldom any actual complaint of interference with the function of the glands, but in a good many cases the secretion of saliva is diminished, and sometimes dryness of the mouth is a distressing symptom. Occasionally the saliva remains normal in quantity and tends to collect in the mouth, while hypersecretion, with salivation to the extent of eight or ten ounces in a day, has been recorded. There is a certain amount of pharyngitis and tonsillitis, but it is rarely possible to get the mouth open sufficiently to see the swelling and œdema of the buccal mucous membrane. Stomatitis may also occur. There is not infrequently some swelling of the cervical lymphatic glands. The parotitis almost invariably subsides completely, but the enlargement may become chronic and remain for months; this, however, like suppuration, is very rare.

Complications.—Severe and complicated cases of mumps occur almost exclusively in persons above twelve, and many of them have been recorded in adults. The following are some—the list does not claim to be exhaustive, since new names are constantly being added to it—of the sequelæ of the disease.

(1) *Local Affections.*—Suppuration is very rare, while it is common in secondary parotitis. Gangrene of the parotid has been observed in two fatal cases, and abscess of the cervical lymphatics may also occur. Cellulitis of the floor of the mouth and œdema glottidis have been reported. All these must be regarded as due to an accidental infection. In this category we ought, strictly speaking, to place otitis media and some cases of facial paralysis, but these will be more conveniently referred to later.

(2) *Metastatic inflammations of other glands,* especially those connected with reproduction. It is difficult to account for the comparative frequency with which inflammation of the parotid gland is associated with abdominal disease (and in this connection it must be remembered that the testicle is an abdominal organ). We see such an association not only in mumps where such conditions occur secondarily to parotitis, but also conversely when we have a secondary parotitis arising in the course of typhoid fever, gastric ulcer, gastric cancer, appendicitis, after laparotomy, etc. The most frequent and important complication of mumps is orchitis. This occurs most commonly in adolescents, and the body of the testicle, not the epididymis, is affected. Orchitis may develop about the third or fourth week from the onset of the disease, it runs an acute course of about a week, and terminates in resolution or atrophy, suppuration being uncommon. Wasting, however, is not infrequently rapid, and the organ may diminish to the size of a bean in a few weeks. There is occasionally some effusion into the tunica vaginalis, urethritis, œdema of the scrotum, and enlargement of the inguinal glands. The left testicle is said to be most frequently affected. When orchitis develops there is always a recrudescence of the constitutional disturbance, with fever, etc. In some cases these general symptoms are severe, and prostration, high fever, and delirium may precede or accompany the orchitis, while in other cases a slow pulse and subnormal temperature have been observed. In addition, signs of intracranial mischief may develop, and some of the nervous sequelæ to be described may mask the orchitis for a time. In rare cases the inflammation of the testicle may precede the parotitis. In the female, ovaritis and salpingitis, œdema of the vulva, mastitis, or enlargement of the inguinal glands may occur, and, while orchitis is seen only in adolescents or young adults, these affections may be seen in quite young female children.

Acute pancreatitis has recently been described. During his convalescence from mumps a lad of ten developed acute abdominal symptoms, and as these subsided a hard mass could be felt in the region of the pancreas.

(3) *Nervous Symptoms.*—Apart from the delirium, etc., due to toxæmia, various complications affecting the nervous system may arise. Meningitis has been recorded in a fair number of instances, either with or apart from orchitis. Recovery is almost invariable, but may be slow, and is sometimes attended by aphasia or agraphia, hemiplegia or monoplegia, ataxia, etc. Acute mania and other forms of insanity have been reported, and so has general peripheral neuritis. Facial paralysis may develop during the course of the parotitis, when we may reasonably conclude that it is due to a spread of the inflammation to the sheath of the seventh nerve, but it has been seen to arise when the glandular affection was very slight, and also beginning a week or two after all inflammation had subsided.

(4) *Affections of the Ear and Eye.*—Otitis media from direct spread of the inflammation, or by an accidental infection passing along the Eustachian tube, is a rarer and less important complication of mumps than nerve deafness. That total loss of hearing may follow mumps is well

known to aurists, and considerable attention has been paid to it by them. Politzer states that sudden incurable nerve deafness following mumps is not uncommon, and that there is neither vertigo nor fever, the lesion being either in the nucleus of the eighth pair, or possibly in the labyrinth. He has seen it precede as well as follow the disease. Most authorities, however, regard it as due to exudation or hæmorrhage into the labyrinth, and describe it as being ushered in by vertigo, vomiting, tinnitus, and sometimes a staggering gait; these disappear, but the deafness remains. Nerve deafness may arise as late as the fifteenth day, one or both ears may be affected, and all are agreed that it is quite incurable.

Optic neuritis and neuro-retinitis followed by optic atrophy, and leading to total blindness, are among the more disastrous effects of mumps, but are fortunately rare. Paralysis of accommodation has been seen, and a condition has been described by Hirschberg as "lachrymal mumps," in which first one and then the other lachrymal gland becomes swollen and painful, the inflammation subsiding in the course of a week or so.

(5) Among the more general complications epistaxis, pneumonia, endo- and pericarditis, arthritis, splenic enlargement, nephritis, gastro-intestinal catarrh, jaundice, and skin eruptions may be mentioned. The nephritis may be attended by hæmaturia as well as albuminuria, and fatal uræmia has been observed on two occasions.

Numerous though these complications are, none are very common; some epidemics are worse than others in this respect, and it has not infrequently been noticed that at one time one series of sequelæ, at another, another group, was prevalent.

Diagnosis.—This is rarely difficult. Symptomatic parotitis is excluded by the absence of any primary disease likely to give rise to it. In young infants enlargement of the preauricular gland is not uncommon; mumps, however, is rare at this age, in most cases of simple adenitis some source of irritation, often about the nostrils, can be found, the swelling is unilateral, and suppuration is common. In older children mumps may be simulated by enlargement of the upper cervical glands, when there is much surrounding œdema, and I have been misled by the occurrence of an enlarged cervical gland in a little boy suffering from unsuspected Bright's disease, with œdema of the cheek and neck. Periostitis of the lower jaw may also resemble mumps. When any difficulty does arise, however, it is usually only temporary, and is solved in a day or two by the implication of the opposite side, and this is, after all, the principal guide at our disposal—the only one, indeed, in cases where the parotids are spared, and the submaxillary and sublingual glands alone involved.

Prognosis.—This is almost always good, especially in children. No matter how severe the complications may appear there is always a fair prospect of recovery. Local septic processes and uræmia have been the most frequent causes of death. Deafness, unless due to otitis media, will be permanent, as is also the case in blindness following optic atrophy. Recovery from the nervous complications is the rule.

Treatment.—Active measures are not required. The patient should be kept in bed so long as the temperature is elevated, and confined to the house until the swelling is gone. In adult males it is probably wise to enjoin more prolonged rest, since orchitis may be caused by allowing the patient to go about too early. The diet should be fluid, on account of the difficulty of opening the jaws. In mild cases the only local application necessary is to cover the inflamed glands with spongiopiline or cotton wool. Should much pain be complained of hot fomentations will be grateful, or the parts may be smeared with equal proportions of extract of belladonna and glycerine, or a little opium and belladonna liniment may be sprinkled on warm flannel, and renewed as required. An antiseptic gargle is useful: Eustace Smith recommends half a teaspoonful of the following formula in a tumbler of warm water as a mouth-wash:—R. Chloroform, ♏xv., Sat. sol. of salol in sp. vini rect. ad ℥j. Complications must be treated on general principles as they arise. An inflamed testicle should be packed with hot cotton wool and covered with oiled silk; leeches may be found useful in relieving the symptoms of meningitis.

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The diseases of the muscular system are possibly one of the most difficult subjects to arrange in a systematic manner: firstly, on account of the ill-defined nature and rarity of some of the affections; and, secondly, because many of the muscular affections are only manifestations of some primary disease of the nervous system. It has been the endeavour of the writer to limit the scope of the present article to those diseases of the muscle which may be considered as primary muscular affections. It is, however, impossible to keep strictly to such a course, and certain affections have been dealt with which will probably in the future be shown not to be primary muscular affections. The subject is a large one, and in order to make the article as comprehensive as possible, and yet not unduly to increase its length, those diseases which are of more ordinary occurrence and of importance have been fully dealt with, while those of rarity and possessing little clinical interest have but short mention.

1. Myalgia, Muscular Rheumatism.—The advantage of making a separate group of the condition known as muscular rheumatism or myalgia may be doubted, for in many cases muscular pain is simply a symptom of some acute or chronic disease. On the other hand, there exists a well-recognised class of affection in which the leading and often only symptom is pain and stiffness in a muscle or group of muscles.

Ætiology.—In an affection having so indefinite a pathology the ætiology is also likely to be indefinite. The majority of cases are attributed to cold, either local, as when a stiff neck results from sitting in a draught; or general, as when a person suffers from general muscular rheumatism after sleeping in a damp bed or on damp ground. The rapid alteration of temperature which occurs when a person who is perspiring freely is exposed to a cold wind, and especially when this is associated with physical exhaustion, would also seem to play a prominent part in the ætiology of the affection. Certain persons are undoubtedly much more liable to the affection than others, and this would suggest that the rheumatic and gouty diathesis has also some influence in their production. There is no evidence that the disease has any connection with acute rheumatism, or that it is the result of any infective process.

Symptoms.—Muscular rheumatism is characterised by pain situated in the muscle. This is increased by active or passive movement, and the muscle is also tender on direct pressure. The pain may be referred to a single muscle, or may affect a group of muscles or even the whole body. Owing to the pain caused by the contraction of the muscle, the body or limb is kept in a fixed position, so that the affected muscle or group of muscles is kept from active contraction, and hence it follows that it is not the affected muscles which are hard and contracted, but the muscles which are relaxed, the other muscles simply acting as a splint to the affected one. So long as the muscle is kept fairly at rest there is little pain, and this distinguishes the pain from that of neuralgia. The condition is unattended by any constitutional symptoms, and there is no disturbance of temperature. On examination of the patient nothing objective can be found, the muscle is tender on pressure, but pressure does not give rise to the acute pain of active or passive movement. The muscle is not swollen, nor is it contracted. Muscular rheumatism tends to affect certain muscles of the body; some of those most commonly involved are those of the neck, giving rise to the condition known as "stiff neck." Not infrequently the pain is referred to the lumbar region and to the muscles of the back (lumbago, *q.v.*), at other times to the shoulder, and sometimes to the abdominal muscles.

A chronic form of muscular rheumatism has been described, in which acute attacks occurring at short intervals make the disease appear of a chronic nature.

Pathology.—No pathological process has been found to account for this condition. Some authors refer the pain to the aponeurosis of the muscle, others to the connective tissue, others again to the tendons. Certain it is that there are end-organs of a sensory nature not only in the aponeurosis and tendon of the muscle, but also in the muscle itself, which are capable of giving rise to afferent impulses of a painful nature.

Prognosis.—The disease is usually of a short duration, and tends to pass off without treatment in a few days.

Treatment.—Treatment consists in the application of dry or moist heat to the part affected. Counter irritation by blisters, leeches, etc., are of some use; massage is also of service, and it is important to exercise the muscles either actively or passively. A Turkish bath will often give great relief, and when followed by massage and active or passive movements, will completely relieve the condition. Salicylates or quinine may be given internally, but local remedies are usually most efficacious.

2. Rupture of Muscle.—It is not proposed to deal here with the condition of muscular stiffness and pain which results after prolonged and unusual exertion, for it may be regarded as a physiological rather than a pathological condition. On the other hand, some of the severer forms of such an affection have been attributed to rupture of some muscle fibres.

Rupture of muscle may be due to—firstly, direct injury; secondly, to the forcible contraction of the muscle; and, thirdly, to a spontaneous rupture in the course of acute febrile conditions in which the muscle has undergone degeneration. The smallest exertion, such as a cough or the shifting of the position in bed, is able to cause rupture of the muscle in these cases.

With regard to the first form it needs no special mention here. In the second form, where the rupture occurs after some forcible contraction in a healthy or, at any rate, not obviously unhealthy muscle, the patient has sudden severe pain in the position of the ruptured muscle, with loss of power of the movements of the affected muscle. In the relaxed position of the muscle the pain is lessened, while it is intensified either by active contraction or passive extension of the muscles. Between the separate ends of the muscle a groove can be felt, though this not infrequently becomes filled up with extravasated blood. The process of repair takes place, and the muscle may be fully restored, though such a fortunate termination is not always obtained.

Rupture which occurs in a muscle during the course of febrile conditions is always due to some pathological change in the muscle fibre. The rectus abdominis muscle is that which is most frequently affected, in other cases the psoas and abductors of the thigh may be affected. The rupture of these muscles may occur whilst coughing, during convulsions, delirium, and during the process of defæcation. The condition most commonly occurs during typhoid fever, and is not infrequently followed by a severe hæmatoma, but it has also been noted in malaria, miliary tuberculosis, phthisis, and tetanus.

Symptoms.—Sharp pain is complained of at the time of rupture which lasts one or two days, and is increased on muscular exertion. Usually a swelling occurs at the seat of rupture which is elastic and gives rise to fluctuation. The muscle may be tender on pressure, and may in such a case give rise to the diagnosis of peritonitis. In spite of the degenerate condition of the muscle recovery generally takes place. The process by which recovery of a muscle takes place is one over which there has been considerable controversy, but it is now generally believed that reconstruction of the muscle fibre takes place from the growing out of the end of the ruptured fibre.

Hernia of Muscle.—This is a rare condition, in which owing to injury a portion of the muscle during contraction becomes extruded through its aponeurosis.

3. Congenital Absence of Muscle.—Scattered throughout medical literature are reports of cases in which certain muscles have been congenitally absent. It would seem from the reported cases that the muscle most frequently absent is the pectoralis major on one side; not a few cases of this sort have been described, giving rise to the absence of the anterior fold of the axilla, and to flattening and depression of the chest wall on the side of which the muscle is absent. This has been associated in some cases with abnormally small arteries on the affected side. The congenital absence of the latissimum dorsi has been noted in conjunction with the absence of the pectoralis major, and in some cases the pectoralis minor has also been absent. The clavicular portion of the pectoralis major generally remains normally developed while the two lower portions are absent. Absence of the abdominal muscle has been described, and also of the semi-membranosus muscle. The interest of these cases is, however, mostly anatomical, except in so far as any deformity produced may be attributed to disease. The absence of the muscle does not necessarily cause any loss of function, for that is generally performed by some other muscle.

4. CHANGES IN MUSCLE DUE TO VASCULAR DISTURBANCE.—The changes which occur in muscles from which the blood-supply is cut off are commonly known under the name of "Ischæmic paralysis," and the most frequent cause of this condition is the too tight application of splints after fracture or other injury. It will be convenient, however, to deal with the subject under two heads: first, the muscular change produced by interruption of the arterial supply; and, secondly, by the obstruction to the venous return.

Affection of Muscle due to Interruption of Arterial Supply.—This depends largely on two factors: in the first place, the interruption of the blood-supply must be nearly complete; and, secondly, it must be of some hours' duration, for it is well known that a temporary interruption of two to three hours is easily tolerated.

Ætiology.—The direct cause of such interruption of circulation is either due to an embolus or thrombosis of the artery of the muscle when the collateral blood-supply is deficient. Embolus is due to some cardiac affection, while thrombosis is due either to some syphilitic endarteritis, or to thrombosis following one of the acute infective diseases. The changes in the vessels which accompany such diseases as Raynaud's, and which are primarily due to some defective nerve innervation, give rise to like ischæmic condition of the muscles. Direct injury to a vessel and cold may also be the cause of the affection, but the most frequent cause is undoubtedly the too tight application of a bandage or splint.

Symptoms.—The first symptom to manifest itself is numbness and tingling in the limb or portion of the limb affected, and this may be combined with some alteration of sensation. Then severe and often paroxsymal pain of a rheumatic character occurs, which is localised in the muscle, and is followed by severe muscular cramp and spasmodic jerkings. The affected limb is pale, sometimes cyanosed and cold. The electrical irritability of the muscle is said to be lost after the ischæmic condition has lasted for five hours, and the muscles are quite flaccid and powerless; after seven hours muscular rigidity and painful contractions begin, these increase in severity, and after two to three days disappear, leaving the muscles again flaccid. An œdematous condition of the muscles now occurs from a partially established collateral circulation, and at this time the muscle is tender on pressure. This swelling gradually disappears, and muscular atrophy becomes manifest, the muscles being hard and firm. Following this atrophy contraction begins to take place, and the hand becomes flexed at the wrist and the fingers at the phalangeal joints. The final contraction of the muscle is due to the atrophy of the muscular fibres and to the formation of connective tissue. Atrophic changes in the skin are commonly present. The course which such condition runs depends to a very large extent on the duration of the primary ischæmic conditions; when once the muscular cramps and rigidity have set in it is probable that no immediate recovery of the muscle is to be looked for, but short of this the muscle may rapidly recover if the blood-supply is restored. In those cases in which the cramps have appeared it is probable that many of the muscular fibres die and have to be replaced by regeneration, a process which is of slow and long duration. In those cases in which the ischæmic condition is of still longer duration, and the muscle has become flaccid, it is very improbable that any large amount of restitution can take place. Certain fibres may escape, and from these new fibres may be formed; the amount of recovery, however, will be small. In such a case muscles rapidly atrophy, become tough, hard, and contracted.

Pathological Anatomy.—Every stage of muscular degeneration and reparation may be met with according to the complete or incomplete interruption of the blood-supply. It will be sufficient to describe two conditions: the first, in which the blood-supply is completely interrupted; and the second, in which the supply is deficient. In the first the muscle is of a grayish dirty yellow colour, dull in appearance, and friable. Under the microscope the transverse striation of the muscle is often more marked than normal, and the longitudinal striation also is very obvious. There is an almost complete absence of muscular nuclei. Fatty degeneration of the muscle does not usually occur. In the second condition, when the vascular supply is only in part cut off, the muscle itself is firm and tough, and has more or less of a normal appearance. On microscopical examination it is seen that there is a great increase of the connective tissue between the bundles of fibres; and, further, it is seen that the individual muscle fibres are separated from one another by intervening connective tissue. Fibres thus separated usually have lost their polygonal form, and have become smaller and are rounded in shape. They, however, retain their striation even when extremely atrophied. Many of the fibres appear to have spaces in them so that they are paler than the surrounding fibres, and on longitudinal section these spaces are seen as longitudinal splitting of the muscle.

Affection of Muscle due to Interrupted Venous Return.—The change in muscle produced by venous thrombosis differs somewhat from that produced by interruption of the arterial-supply. The acute symptoms are those of thrombosis of the vessel in the limb, viz. swelling, cyanosis, and œdema. The limb feels full, hard, and is tender on pressure. The acute symptoms may pass off, but the limb is left in a condition of passive congestion, and the result of this is that the muscles and limb become larger than the corresponding limb, and a condition of pseudohypertrophy is produced.

Pathological Anatomy.—The condition found in the muscle during the early stage is one of increase of the intermuscular and connective tissue. In the later stages the connective tissue becomes more abundant, and there is some atrophy of muscles, fibres, and fatty degeneration.

Hæmorrhage into Muscle.—This occurs in the course of acute febrile disease, poisoning by phosphorus, severe jaundice, in hæmophilia and scurvy, and in other forms of arterial degeneration.

5. FORMS OF MUSCULAR DEGENERATION.—Short mention need only be made here with regard to the forms of muscular degeneration; they occur for the most part in the course of prolonged febrile diseases, or as the result of some acute toxic condition. Three forms are usually described—(1) fatty degeneration; (2) hyaline degeneration; and (3) vacuolation of the muscle fibre.

(1) *Fatty Degeneration.*—This may occur in the course of any of the acute specific fevers, in septicæmia, and in acute and chronic tuberculosis. It occurs in the course of various nervous affections in which there is atrophy and wasting of muscle, and it has also been shown to occur as the result of status epilepticus. The muscle also shows fatty degeneration in extreme wasting condition, whether produced by want of food or disease, and in poisoning by phosphorus and arsenic.

Pathology.—In slighter cases the naked-eye appearance of the muscle is normal, while in the severer cases it is easily friable, yellowish in colour, and has not its normal glistening appearance. On microscopical examination of a muscle treated with osmic acid, one sees in the slighter cases small black granules scattered throughout the muscle, the transverse striation being still preserved. In more advanced conditions these black dots become more numerous, and arranged in a longitudinal manner; and in a still later stage the transverse striation of the fibre disappears, and fat granules are thickly distributed throughout the muscle fibre, while in the last stage the muscle fibre breaks down, and large droplets of fat are seen lying between the fibres, and the perivascular lymphatics are blocked with fat.

(2) *Hyaline Degeneration.*—This form of muscular degeneration has been most frequently found in the course of typhoid fever; it occurs also, however, in septic conditions, after pneumonia, influenza, miliary tuberculosis, rheumatic and scarlet fever. When occurring during the course of typhoid fever, it is met with at the end of the second week, and affects most commonly the abductor muscles of the thigh and the rectus abdominis muscle. The symptoms usually complained of are extreme feebleness and sometimes pain in the affected muscles, which are very flabby. After the fourth week repair of the muscle begins to take place, and it eventually becomes completely restored. The muscle is pale, flaccid, and slightly œdematous. Under the microscope portions of muscle fibres are seen to be swollen, so that when cut longitudinally the fibre has an irregular margin with transparent degenerate areas. The fibres are broader, two to three times greater than normal, and have either a homogeneous appearance or a fine longitudinal striation, the transverse striation being only just visible. Spaces and holes occur in the fibre. The number of nuclei in the sheath of the fibre is unaltered.

(3) *Vacuolation.*—This condition is found under almost any condition which gives rise to muscular degeneration. It is present in muscles after typhoid fever, in myositis, in myopathy, and after nerve degeneration. Under the microscope the condition appears as a clear space in the muscle fibre, there may be only one of such spaces, or they may be grouped together so as to form a complete vacuolated area in the centre of a fibre. On transverse section of the muscle some of the muscle fibres seem completely replaced by a single large vacuolation, while in others there are numerous small vacuoles. The nature of the material which fills up these spaces is said to be a fluid albuminous body.

6. Inflammatory Diseases of the Muscles

The difficulty of dividing this subject into suitable groups is considerable, but the following classification seems open to the least objection:—

A. *Primary Affection of Muscles.*
  (1) Polymyositis.
    i. Acute polymyositis.
    ii. Hæmorrhagic myositis.
    iii. Myositis which accompanies urticaria and erythema.
  (2) Neuromyositis.
  (3) Tuberculous myositis.
  (4) Syphilitic myositis.
    (*a*) Diffuse syphilitic myositis.
    (*b*) Muscle gumma.
  (5) Myositis due to trichina.

B. *Secondary Affections of Muscle in the Course of some Acute or Chronic Disease.*—They may be either suppurative or non-suppurative, parenchymatous or interstitial. Infective myositis occurs in pyæmia, puerperal fever, ulcerative endocarditis, glanders, infective wounds, actinomyositis, erysipelas, and gonorrhœa.

C. *Myositis ossificans.*

(1) *Polymyositis.*

The form of this disease known under the title acute polymyositis or dermato-myositis has only recently been recognised as an entity.

Ætiology.—The cause of the disease is obscure. Two hypotheses have been suggested: firstly, that the disease is due to a toxin; secondly, that it is due to an animal parasite of the group Gregarinæ. Neither of these hypotheses have been proved, and careful bacteriological examination of the muscle has given a negative result. The suggestion that the condition is due to a toxin derived from the ingesta would be that which would seem most probable, for cases have been reported in which the disease has followed on the eating of stale crabs, and also of fish in poor condition. The suggestion that the condition is due to a gregarine is based on the occurrence in the lower animals of myositis due to a protozoom, but such has not been proved to be present in man.

The disease has occurred in the course of diabetes, phthisis, tuberculous disease of the intestine, and after injury to the tongue. The disease is not contagious.

Age and Sex.—Of eleven cases collected by Pfeiffer, four were in women, seven in men. The youngest case occurred in a patient aged 17, and the oldest in a man aged 70.

Symptoms.—The disease is characterised by swelling of the extremities, due to an inflammatory œdema of the subcutaneous tissue and muscles, attended by acute pain and rigidity of the muscles, great tenderness on pressure, and an erythematous rash resembling erysipelas situated over the affected parts. The onset of the disease is gradual with malaise, weakness, loss of appetite, headache, and sometimes vomiting. There is usually a moderate rise of temperature, and the local symptoms manifest themselves by acute pain of a cramp-like character and tenderness, beginning usually in the legs and arms. Shortly after the temperature begins to rise swelling of the skin and subcutaneous tissue appears. This swelling starts usually in the limbs, forming a very solid œdema which does not readily pit on pressure. At a later stage the œdema spreads to the face and eyelids. The muscular pain is intense, and is increased by the slightest movement. The spleen sometimes becomes enlarged, and the patient sweats excessively. At the commencement of the illness the pain is not generally so severe that the limbs cannot be moved; later, however, the least movement causes so much pain that the patient lies helpless in bed. Other muscles of the body may become affected, the diaphragm, the intercostals, and the muscles of deglutition, so that there is great difficulty in speaking and swallowing. The muscles of the eye and tongue are also sometimes affected. Sensation is perfectly normal, and the nerves are not tender on pressure. The joints are unaffected. The knee-jerks are generally present, though the swollen condition of the limb and the pain caused by percussion may give rise to some difficulty in obtaining them. The electrical reactions in the earlier stage of the disease have been found to be normal, while in the later stages alteration has been present. The urine is generally normal, but it may contain some albumin. The course of the disease tends in the slighter cases to recovery after a duration of some weeks, although occasionally recovery is much more rapid. In the severer forms convalescence is very protracted, atrophy of the muscles following the subsidence of inflammation, and pigment changes occurring in the skin. In the severest cases death takes place from affection of the respiratory muscles, or from secondary affection of the lungs, bronchitis, or pneumonia.

Diagnosis.—The disease as above described has certain definite features, a gradual onset attended by inflammatory swelling of the muscles, together with redness and swelling of the skin and subcutaneous tissue situated over the involved muscles, extreme tenderness without loss of sensation, the joints being unaffected. Such symptoms form a clinical picture which renders the diagnosis one of no great difficulty in typical cases. The symptoms resemble those produced by trichina in some points, and especially the swelling of the face and eyelids. This symptom, however, in trichina comes on at an earlier period, and the swelling of the face and eyelids is an early symptom, while in polymyositis it is a late manifestation. The discovery of the trichina in the motions or in an excised portion of the muscle confirm the diagnosis. From polyneuritis the disease is distinguished by the more marked paralysis, the anæsthesia, the early and more rapid atrophy, the loss of knee-jerk, and the absence of the characteristic skin-affection in that disease.

Morbid Anatomy.—The subcutaneous tissue is infiltrated with a yellowish serous fluid forming the hard œdema. Almost any muscle of the body may be affected, but the masseter and ocular muscles usually escape. The muscle itself shows widespread alteration. It is usually of a dirty yellowish white colour, in which brownish red patches appear. Hæmorrhages can be seen in the muscle, which is soft and friable. The microscopical examination shows both a parenchymatous and an interstitial inflammatory condition which may be either focal or diffuse. The muscle fibres are swollen and granular, and for the most part have lost their striation; hyaline degeneration and vacuolation is often present, but fatty degeneration does not occur. Increase of round cells between the fibres is always present, and hæmorrhages can be seen in these situations. It is generally considered that the disease is primarily an affection of the connective tissue, and that the muscle fibres become affected secondarily.

Polymyositis Hæmorrhagica.—Of this variety of polymyositis comparatively few cases have been described, the symptoms and the pathological conditions are so distinct from dermato-myositis that it deserves separate mention.

Ætiology.—As with dermato-myositis so with hæmorrhagic myositis, the cause is obscure. Some cases have followed on acute throat infection, but in other cases no such definite preceding condition has occurred.

Symptoms.—The onset of the disease may be attended with moderate rise of temperature and with localised pain in the muscles, generally the calf or the thigh. The muscle is swollen, and the swelling generally has a purple appearance, the surrounding tissue being œdematous. The swelling thus formed may disappear, and then reappear in some other portion of the body; after a short time several such swellings appear. The pain is usually acute, and all movement is very much impaired. The affected extremity is swollen, hard, very painful on pressure, and feels hot to the touch. The skin is not usually so much affected as in dermato-myositis, but there is often a rash having somewhat the appearance of measles, sometimes that of purpura, and at other times there is very marked vasomotor disturbance, so that any pressure or rubbing of the skin produces a bright red spot. Actual subcutaneous hæmorrhages not infrequently occur. After the subcutaneous œdema has disappeared hard and tender swellings can be felt in the affected muscles. Atrophy of the muscle now begins to take place. Shortly after the onset of the disease the rapidity of the heart's beat is greatly increased without there being any obvious cardiac lesion. On electrical examination the muscles generally show some quantitative change. The knee-jerks are obtainable, and sensation is natural. Nothing abnormal can be detected in the internal organs, although the spleen is sometimes enlarged. Some cases however, have had hæmorrhage from the intestines.

Course.—The disease is usually fatal from failure of the cardiac action and hypostatic congestion of the lungs. In one case, however, recovery took place.

Pathological Anatomy.—The muscles appear of a dirty brown colour, and hæmorrhagic foci can be seen between the muscular fasciculi. The heart muscle shows the same brown colour with small hæmorrhages. Microscopically during the acute stage intermuscular hæmorrhages are found, the muscular fibres are separated from one another by the extravasated blood. The muscle fibres have lost many of their nuclei, they may be vacuolated, and show hyaline degeneration. In the later stages there is extreme atrophy of the muscle fibres, and the connective tissue is greatly increased, and the remains of blood pigment is often to be seen.

Polymyositis which accompanies Urticarial and Erythematous Affections of the Skin.—Besides the varieties of the disease above described, a very interesting condition is seen in association with urticaria and erythema, which instead of producing the severe affection described in the last two varieties tends rapidly to improve, leaving the patient in a few days restored to his usual health. The ætiology of the disease is obscure. Cultivations from the muscles are negative. In one case that was brought under my notice the condition was produced by eating shell-fish, and was accompanied by severe urticaria, and one cannot but regard the disease as similar in origin and cause to urticaria, and probably due to a poison of intestinal origin.

Symptoms.—In the slighter forms of the disease the symptoms come on suddenly, with severe urticaria of the skin and swelling of the muscles generally limited to the lower extremities. In the muscles themselves spindle-shaped swellings can be felt about the size of a man's thumb, the skin eruption disappears in the course of twenty-four to forty-eight hours, and the muscular swelling also becomes absorbed in about the same time. In the severer forms the lower extremities are considerably swollen, and the skin is œdematous and presents the condition seen in erythema nodosum. The limbs feel hot and are tender on pressure; the muscles are hard, and small areas of induration can be felt in them. The patient can only move the legs with difficulty, and passive movements give rise to severe pain. The disturbance in temperature is not as a rule great; occasionally the joints become involved. The electrical irritability of the muscles is much diminished.

Course and Prognosis.—The disease tends to rapid recovery; in the first form the duration is but a few days, while in the latter, although the acutest symptoms may pass off in a week, yet there frequently remains great tenderness of the bones and muscles which may persist for a considerable period. Again there is a tendency for this form to recur. Muscular atrophy is said to occur after the disease.

Morbid Anatomy.—So far as observation goes from the examination of excised portion of muscle, there is an exudation of small cells in the muscle without any change in the muscle fibres themselves.

(2) *Neuromyositis.*—This name has been given to a form of myositis which is generally considered of rheumatic origin. The disease usually affects one limb which is tender, and pain is especially caused by muscular contraction. The joints and the nerve-trunks may be affected, but are tender to a lesser degree than the muscle. The disease occurs in patients

after the second half of life, and usually follows on rheumatism. The symptoms indicate an interstitial inflammation of the muscles affecting the tissues in which the afferent nerves begin. The arm while at rest gives rise to but little pain, but the sudden contraction of the muscle caused by passive movement gives rise to great pain in the muscles. If, however, the arm be moved slowly and steadily a wide range of movement is possible, and it is only the occurrence of a more sudden movement that causes sudden spasmodic contraction of the muscles to take place, and then the pain in the muscles becomes great. The fear of this pain usually results in the arm being held in a fixed position. The muscles are tender to touch, and are somewhat wasted and flabby. The disease is of long duration, and it is only by prolonged and patient treatment that improvement slowly takes place. The disease here described is that recognised by Gowers under the above title; there is, however, a disease described by Senator which is widespread and acute, and closely resembles acute myositis above described.

(3) *Tuberculous Myositis.*—Two forms of this disease are described: (1) in which the disease spreads from the neighbouring joint or bone into the muscle; and (2) in which the disease commences in the muscle itself. Of the first form nothing need here be said. With regard to the second it occurs most frequently in young persons who are already the subject of tuberculous disease.

Symptoms.—The disease is of gradual onset, giving rise to some pain and swelling in the muscle. The mass is usually situated in the middle of the muscle, and is neither directly connected with the neighbouring tissue nor with the skin. The swelling is only tender on firm pressure, and often is quite painless. The function of the muscle remains good. The disease always runs a chronic course, the local condition giving rise to but little trouble; an abscess, however, may form.

Morbid Anatomy.—The tuberculous mass lies in the muscle surrounded by a thick connective-tissue wall, the surrounding muscle is often indurated, and there is considerable interstitial change.

(4) *Syphilitic Myositis.*—This disease manifests itself in two forms: (1) Diffuse syphilitic myositis; and (2) Muscle gumma. These two varieties will be described separately.

(*a*) *Diffuse Syphilitic Myositis.*—The period at which this disease is liable to occur after the primary infection is very varied, one author stating that 50 per cent of the cases occur during the first twelve months after primary infection, while others state that it commonly occurs three to four years after the primary infection, and it may be eleven or twelve.

Symptoms.—The disease is gradual in its onset, and attended with considerable pain in the affected muscle, which is usually worse at night; movement, whether active or passive, greatly increases the pain. There is greatly diminished power in the muscle. The muscle feels hard and brawny and is tender on pressure, the skin is reddened and feels hot to the touch, while in other cases the skin is quite natural. The limitation of movement in the muscle is due to its inflammatory infiltration. The muscle most commonly affected is the biceps, but almost any muscle of the extremities may be affected, and the condition has been described in the masseter and sphincter ani. The electrical examination of the muscle shows only a quantitative change with no reaction of degeneration. The recovery is slow, and often attended by a considerable atrophy in the muscle or muscles affected. Many cases, however, recover completely.

Pathological Anatomy.—The microscopical appearances described are dilatation of the vessels, thickening of their walls, exudation of small cells, and at the same time proliferation of the muscle nuclei, lying in part between the primitive bundles and in part within the bundles. In later stages of the disease there is an increase of the interstitial connective tissue, and the individual muscle fibres become separated from one another; lastly, the muscle fibres themselves become opaque and their contents granular, and the striation of the fibre disappears. Some fibres, however, undergo simple atrophy, and then the striation is preserved even in the smallest fibres.

(*b*) *Muscle Gumma.*—This condition is stated to occur at a later period than the foregoing affection, and may manifest itself as long as thirty years after the primary infection. The affection is attended by very little pain, and the first thing that the patient notices is a hard swelling in the muscles, which is not tender on pressure, although some pain may be produced by putting the muscle into action. The muscle most commonly affected is said to be the sterno-mastoid, after that the quadriceps extensor, the calf muscle, the biceps muscle of the arm, the masseter, and the pectoral. The affection is sometimes symmetrical. The central portion of the muscle is that which is most commonly affected. The presence of the tumour gives rise to very little disturbance in function.

The course which the disease runs depends largely on the rapidity of the formation of the gumma; when this has been rapid, and is treated in an antisyphilitic manner, recovery rapidly takes place; when, however, the tumour has slowly developed it also slowly disappears, and may leave a hard indurated mass in the muscle. The tumour which is seen in the sterno-mastoid muscle of infants is by some attributed to a gumma in the muscle, and this is probably correct in a small proportion of the cases. In these cases the tumour is not noticed at birth, but seems to develop in the first few weeks of life. The swelling disappears under mercurial treatment, but it is always difficult to say whether such a condition may not have been due to some inflammatory swelling taking place around an injured muscle.

Pathological Anatomy.—The muscle tissue around the gumma is generally considerably altered, there is a small cell infiltration and increase of the interstitial tissue between the muscle fibres. The striation of the muscle is generally retained. The vessels are thicker than normal, and dense fibrous bands lie between the muscle fibres.

(5) *Trichiniasis.*—A disease dependent on the invasion of muscle by the parasite "trichina spiralis" derived from infected pork.

Symptoms.—Three stages are described in this disease: first, a stage of intestinal irritation commencing soon after the taking of the infected meat; second, a stage of severe muscular pain with pyrexia; and, third, a stage of subsidence during which the trichina becomes encysted in the muscle. Cases, however, vary in severity according to the extent of the infection. During the first stage there is vomiting, diarrhœa, furred tongue, abdominal pain, and cold extremities. These symptoms may manifest themselves within a few hours after taking the diseased meat. The severity of these symptoms is no guide to the future severity of the case, for, as has been pointed out, the excessive diarrhœa and vomiting tend to the removal of the trichina before their young have had time to penetrate the walls of the intestine. The acute symptoms now pass off, but diarrhœa may continue, and about the eighth day of the illness puffiness of the face and eyelids occurs; this lasts a few days. About the ninth or tenth day after infection pains are complained of in the muscles; these gradually increase in severity. The temperature is raised usually between 102° and 103° F. The muscles become swollen, hard, and brawny, are very tender on palpation, and active or passive movement gives rise to severe pain. Almost any muscle of the body is liable to be affected, but the implication of the diaphragm, intercostals, and laryngeal muscles impeding respiration, and the implication of the masseter, tongue, and pharyngeal muscles affecting deglutition, very seriously interfere with the performance of vital functions. The patient lies in bed with the legs flexed. Œdema of the trunk and limbs occurs about the fourth or fifth week, and attacks of profuse perspiration also take place. Wasting may now occur, and the patient passes into a typhoid state with great prostration, stupor, and delirium. Pulmonary complications are liable to occur. The duration of these severe symptoms is about five to six weeks, after which convalescence sets in, and in a few weeks the patient is well again. Some cases are, however, much more protracted. Death usually occurs during the fourth or fifth week, and is immediately due to the involvement of the respiratory muscles and secondary pneumonia.

Diagnosis.—Trichiniasis is most likely to be mistaken for typhoid fever, the presence of muscular swelling and tenderness, the œdema of the face and limbs, the presence of trichina in the stools and the absence of enlargement of the spleen, and a negative Widal reaction, would, together with a consideration of the onset, be sufficient to arrive at a correct diagnosis. The disease has also to be distinguished from beri-beri by the more marked involvement of the nervous system in that disease, viz., the absent knee-jerk and the anæsthesia. From acute polymyositis the diagnosis is by no means so easy, the swelling of the muscles is an earlier manifestation in polymyositis, and there is more affection of the skin. The presence of trichina in the motions would make the diagnosis certain.

Treatment.—When the trichina has invaded the muscle no drug has the power of destroying it. The removal of the parasite from the intestines should be carried out by purgatives, and the constitutional symptoms must be treated in the usual manner.

B. *Secondary Affection of the Muscles.*—Muscles may become secondarily affected from structures in their immediate neighbourhood, either from a suppurative inflammation in the skin, in the subcutaneous tissue, in the joints, in bones, or glands, the infection spreading directly from the part involved to the muscle. On the other hand, a suppurative myositis may arise from infection through the blood-stream; such a condition is liable to occur in pyæmia, in ulcerative endocarditis, puerperal fever, glanders, actinomycosis, and from an infected wound or boil. Suppuration also occurs sometimes after the acute specific fevers, but when this is the case it can be shown that the abscesses so formed contain streptococci, staphylococci, and other organisms, and therefore are true infective processes, and not directly due to the original fever. The symptoms which attend such infective myositis are those of the general diseases, the symptoms connected with muscular condition being little in evidence.

Pathology.—The appearance of the muscle varies with the intensity and duration of the disease. The muscle has usually a dirty red colour, and on pressure a grayish-red fluid exudes; small focci of suppuration are present in the muscle. On microscopical examination of the muscle the transverse striation is absent, and there are numerous small round cells and extravasated blood between the muscle fibres, and in suitably stained specimens streptococci can be seen. The occurrence of actual abscesses in the muscle would seem to depend on the length of time that the disease has existed, for in some cases in which the general infection has been very acute no abscesses have been found, whereas in long-standing cases numerous abscesses occur. Should recovery take place the condition of the muscle would not differ from that of a fibrous myositis from any other cause.

Gonorrhœal Myositis.—Another form of myositis secondary to infection must have separate and rather special mention, as it does not fall into the line with other forms of infective myositis. This disease generally accompanies gonorrhœal rheumatism, and commonly affects muscles in the immediate neighbourhood of the affected joint. The affection is generally local and limited to one muscle, the gastrocnemius, deltoid, or biceps being most commonly affected. The muscle is hard and swollen, tender on pressure, and feels hot to the touch. The limb is held in a fixed position, and the skin may also be affected. The acute symptoms are not of a long duration, but the muscle remains hard and infiltrated for some time; the process gradually clears up, leaving the muscle somewhat atrophied.

Fibrous Myositis.—It may well be questioned whether such a disease as primary fibrous myositis exists, such cases having usually been regarded as either secondary to some acute condition, or have been designated "rheumatic." Foreign authors regard it, however, as an entity, and, therefore, it may be well to give a short account of the disease.

Symptoms.—Fibrous myositis is a chronic disease of gradual onset, affecting either a single muscle or a group of muscles, or it may be general. The lower extremities are usually first affected, but the disease may begin in the sterno-mastoid muscle. The patient complains of a drawing pain in the affected part, there is stiffness of the limbs and contraction of the muscles. They become very hard, but are not especially painful on pressure. The course of the disease is very protracted, but it is said that under suitable treatment there is a tendency to recover.

Morbid Anatomy.—There is an increase of the interstitial tissue, and some of the muscle fibres are granular and others are atrophic. The blood-vessels are normal.

(*c*) *Myositis Ossificans.*—This disease is characterised by a progressive bony formation in the muscles, with the result that the patient comes to be in a fixed and immovable position.

Ætiology.—The disease commonly affects the young, and generally starts before the fifteenth year of life. Of 45 cases, in 11 it was noticed during the first year of life, in 16 from one to five years, in 11 from five to fifteen, and in 7 after fifteen years of age. Males are rather more liable to be attacked than females, the proportion being about two to one. The direct cause of the disease is unknown; trauma seems to be the most frequent ascribed cause of the onset.

Symptoms.—The earlier symptoms are usually ascribed to inflammation of the muscle, following on injury, at other times the disease begins quite insidiously, there are attacks of pain which occur at intervals, and are usually ascribed to rheumatism. Small hard masses may now appear in the muscle, which slowly becomes larger, or, what is rather more frequent, remains stationary for some time, and then during an exacerbation of the disease rather rapidly grows, and then again during a quiescent period remains about the same size. The disease, however, steadily advances, small masses of bone can be felt in the muscle, and these gradually increase in size and become fused with one another. The muscles most commonly affected are those of the back of the neck, back, and thorax, and less frequently those of the arms, legs, and jaw. Owing to the affection of the muscles of the back, rigidity and fixidity of the spinal column is produced, so that the head becomes bent forward, the back curved, the position giving to the patient an appearance which is most characteristic of the disease.

The shoulder-blades may become fixed to the thorax, and as the pectoral muscles are often affected the arms become fixed to the sides, and the patient can no longer raise the arms to his mouth in order to feed himself. The disease progresses and the patient becomes less and less capable of any movement, and the rigidity is such that any attempted movement of the arm by another person only results in the movement of the patient "en bloc." The limbs become flexed owing to the shortening of the muscles. The thorax may now be simply a bony cage in which no respiratory movement is possible, the whole of respiration being carried on by the diaphragm, the masseters may also be so affected that the jaws are tightly closed together, making the feeding of the patient a matter of some difficulty. Even at this late stage of the disease fragments of bone of a fantastic shape can be felt in the muscle free from any attachment to the skeleton. Certain muscles are said never to be affected; these are the muscles of the face, the platysma, the eye muscles, the tongue, the muscles of the œsophagus and larynx, the diaphragm, heart, muscles of the perineum, the genital apparatus, and the sphincters. The great toes are often abnormally small owing to some defect in development of the phalanges, and a similar malformation has been described in the development of the thumb. The course of the disease is very prolonged, the patient remaining for long periods in a stationary condition, and at intervals suffering from the acute exacerbation of the disease above described.

Pathology.—Two views are held with regard to the pathology of myositis ossificans. The first is that the condition is an inflammatory one, and the second is that it is a new growth similar to multiple exostoses. The examination of the new formed bone would seem to show that it is true bone, having the normal chemical constituents and the anatomical characters of true bone. The growth originates either from the bones themselves, from the tendons, or from the fascia and connective tissue of the muscle. The atrophy of the muscle is secondary to the affection of the intermuscular tissue.

7. NEW GROWTH IN MUSCLE.—Primary new growth in muscle is rare, and needs but short mention here. Sarcomata, fibro-sarcomata, myxo-sarcomata are the most frequent neoplasms of muscle. The growth develops from connective tissue, and secondarily causes atrophy and destruction of the muscle fibres. The following growths are of rarer occurrence: fibromata, lipomata, angiomata, myxomata, and enchondromata. Carcinoma of the muscle occurs only as secondary to a primary process in some other situation. A few cases of rhabdomyomata have been described. Hydatids have also been found in muscle.

8. MYOTONIA CONGENITA—THOMSEN'S DISEASE.—*Definition.*—A disease characterised by a prolonged contraction of muscles on the attempt to perform any voluntary movement.

Ætiology.—Heredity plays the most important part as an ætiological factor. The disease exists in certain families, and passes from parent to child, affecting both brothers and sisters in the same family. Other members of the family have suffered from mental weakness. The age at which the onset of the disease occurs is doubtful, but it is probably congenital, although patients do not as a rule complain till some time during the second decade of life. Males are rather more frequently affected than females. In a few cases the disease appears to have been acquired, in one such case following on severe exertion, and in another after a sudden alarm.

Symptoms.—The most striking symptom is that on attempting to perform any voluntary movement, the muscles associated with that movement and their antagonistics go into a state of prolonged contraction. Gradually the antagonistic muscles give way and the movement is performed; both the contraction and the relaxation of the muscles is very much prolonged. By repeating the movement frequently the action becomes more and more readily performed, so that after a short time the patient performs all the movements in a normal manner. The difficulty which the patient experiences on starting to walk is very marked, and this is especially noticeable in such actions as drilling, when the movement is expected to be briskly and sharply executed. When starting to walk, the first leg put forward becomes stiff, and remains so for a few seconds, the other leg becoming stiff when it is moved. The second time the first leg is moved the duration of the stiffness is less, so that after a few steps the patient walks in a normal manner, and will walk miles without trouble. Should he however stop, when starting again the same difficulty occurs. As with walking, so with other movements of the upper extremity or face. The opening and shutting of the mouth, the putting out of the tongue, the turning of the head, the grasping of an object with the hand, all show the same slow contraction and relaxation of the muscles which is seen during walking. This has been graphically recorded by a myographic tracing, which shows the slow contraction and relaxation of the earlier muscular efforts. Mental excitement and alcohol seem to have no influence on the condition. Cold and fatigue, however, are said to make the symptoms more pronounced. There is no difficulty in swallowing, in micturition, or defæcation. Any of the voluntary muscles may be affected, but those least commonly so are the muscles of the eye and of the larynx. The muscular development is usually good, indeed it often seems to be in excess of the voluntary power. Sensation is natural.

Electrical Reactions.—The "myotonic reaction" of Erb is present in the muscles, and its characters are as follows:—(1) The nerves show no increase of irritability to mechanical stimulus. (2) To the faradic current the nerves are quantitatively normal, but if the current be strong, the contraction produced on closing the circuit lasts much longer than it does in health. (3) To the galvanic current the nerves are quantitatively normal, but here also, if the current is strong, the contraction lasts longer than in health. (4) Mechanical stimuli applied to the muscles, as by hitting them, induces contractions more easily than in health. These contractions often last from five to thirty seconds. (5) The faradic current applied directly to the muscle, if strong, sets up contractions which last from five to thirty seconds. (6) When the galvanic current is applied directly to the muscle, the K.C.C. and the A.C.C. are equally easy to obtain, while in health, as is well known, the K.C.C. is more readily elicited than the A.C.C. With weak currents the contraction lasts longer than in health, with strong currents it lasts some seconds, and relaxes very slowly (Hale White).

Pathological Anatomy.—This is based chiefly on the examination of excised portions of muscle, though an examination has been made on one case, post-mortem, and nothing abnormal could be found in the brain, spinal cord, or nerves. The marked alteration which is present in the muscle fibres is their increased breadth. The normal fibre measures about ·04 to ·06 mm. in diameter, while in Thomsen's disease they measure nearly double their normal width. The transverse striation is feebly marked, and the nuclei of the sarcolemma are increased in number. Vacuolation is present in some of the fibres. The disease is regarded by all observers as a congenital one, and as purely muscular. Hale White calls attention to the fact that the peculiar contractions are exactly the same as those which may be produced in animals which have been poisoned by veratria. Ringer and Sainsbury find that if phosphate of soda is given to an animal, and the sciatic nerve then stimulated, contractions like those of Thomsen's disease are produced, and this even if curare had been previously injected. From this it would appear that Thomsen-like contractions are due to the action of phosphate of soda on the muscle fibres themselves.

Treatment.—No treatment has been found to influence the course of the disease. It is probably well, however, that the patient should live a life of active muscular exercise.

9. Idiopathic Muscular Atrophy and Hypertrophy.

Introduction.—Under this title a group of cases is described which is often known under the heading "Myopathy." Several types of this disease exist, and for the purposes of description they will be divided into four groups: (1) The infantile type; (2) the juvenile type (Erb); (3) the pseudohypertrophic type; and (4) the facio-scapulo-humeral type (Landouzy-Déjerine). But although for the purposes of description such a division is convenient and may with justice be adopted, it must be remembered that there are many cases which do not conform to any of the above types, but possess some of the characters of each type. In fact it is possible to find cases which form connecting links between all the types.

General Considerations.—The characters which the various types of this disease possess in common are, slow progressive loss of power in muscles or groups of muscles which do not correspond either to a spinal or nerve distribution, the absence of all fibrillary contractions of the muscle so frequently seen in cases where the disease is of myelopathic origin, the marked tendency of the disease to affect families and to pass from parent to child, the absence of any qualitative electrical change, the absence of any disturbance in sensation, or in the condition of the sphincters, and the absence of affection of the muscles of the larynx, pharynx, and diaphragm.

(1) *Infantile Type.*—The special characters of this type are that the disease begins in infancy, the weakness is not necessarily noticed at the time of birth, but generally between the third and sixth month of life. The babe does not learn to sit up, or if it does it is only late in doing so. At a somewhat later age, when put into a sitting position, it may be able to maintain the erect position, especially with the aid of the side of the cot, but if anything upsets its balance, it rolls over, and is not again able to assume the sitting position. The child is generally perfectly contented to lie in the position in which it has fallen or is placed. As the child grows it learns to talk at the usual age, is bright and intelligent, but it makes no attempt to walk. Such a child, if seen about the age of three years, presents the following conditions: The child will sit up in bed, the back being held very straight and the head erect. The arms and legs are very thin, but no localised atrophy or hypertrophy of the muscles can be made out. The lower portion of the pectoralis major is fairly developed in relation to the condition of the other muscles. Some of the leg muscles may feel rather tough and hard, but there is no hypertrophy. All the movements of the face and also of the arms are well performed, although the latter are weak; and the same may be said to be true with regard to the legs, all movements being capable of performance, though weakly. If such a child be placed on its back and asked to sit up, not infrequently it will be quite unable to do so, or it will rotate itself on its long axis, so that its face is turned to the

floor. The legs are drawn up under the abdomen, and then by a process of pushing by the hands the trunk is raised to an erect position. Even this cannot always be done without the aid of some lateral support such as the side of the cot. The trunk now having been placed in an erect position, the legs are manipulated so as to bring them again in front of the trunk, but great care has to be exercised so as not to disturb the equilibrium. As a rule the legs are somewhat flexed at the hip and knee joints by the contraction of the flexors of these joints, and cannot be fully extended. If the child is placed on its legs it will support its weight and make some attempt at progressing, but it can neither walk nor stand without some support. The bones of these children are always very small and thin, and if an attempt be made to lift them by grasping the upper part of the humerus, the loose condition of their shoulder joints, so characteristic of myopathic affections, is at once noticeable. The intellectual development of these children is often very good, from the fact that they have been unable to get about like other children, and have had to amuse themselves or to be amused in other ways. The superficial reflexes are usually present, the knee-jerks are generally diminished or absent, according to the degree to which the atrophy has progressed. The sensation is natural, and all the functions are well performed. The electrical reactions show a greatly diminished reaction both to faradism and galvanism without any qualitative change. It is interesting also to note that these children will bear, without the least appearance of pain, a faradic current so strong that it cannot be borne by the normal adult. The disease is very slowly progressive, and apart from intercurrent disease does not tend to shorten life. This form of disease is markedly familial, brothers and sisters of a family being alike afflicted, but it does not seem to pass from parent to child. This may be accounted for by the extremely crippled condition in which the child is from a few years after birth onwards. The disease is very slowly progressive, and though not fatal in itself, the hold on life which these patients possess is very small, and they rapidly succumb if attacked by ailments which to a normal child would be trivial.

(2) *Juvenile Type* (*Erb*).—This form of muscular atrophy commonly makes its appearance, as its name implies, during the second decade of life. Many authors describe it with that variety known as the facio-scapulo-humeral type. But although they are closely allied, it has seemed to me that this form does in its most typical form possess characters which warrant a separate description. These may be briefly stated as follows:—(i.) the absence of affection of the face, (ii.) the occurrence of hypertrophy, and (iii.) the age of incidence, *i.e.* during the second decade of life. The disease is a familial one and affects both sexes alike.

Symptoms.—The weakness commonly begins in the arms, the shoulder-blades may be noticed to stand out and the arms to become thin; the muscles which are the most markedly affected are the biceps, triceps, pectoralis major, latissimus dorsi, trapezius, rhomboids, serratus magnus, and supinator longus, while the deltoids, supra- and infra-spinati often appear abnormally large. The muscles of the forearm and the hand are usually well developed, and the contrast between the upper and fore arm is very striking. The muscles of the neck and face are normally developed. The muscles of the thigh and pelvic girdle are generally affected somewhat later than those of the arm, but the atrophy of the quadriceps extensor, the biceps femoris, semitendinosus, semimembranosus, adductors, and the glutei is very considerable, and the appearance of a patient affected with this disease is very striking, for the thighs and upper arm are very thin, while the legs below the knee and forearm are well developed. Sensation is unaffected. The electrical excitability of the muscle is diminished, but there is no reaction of degeneration. The progress of the disease is very slow.

(3) *The Pseudohypertrophic Type.*—This form has certain well-marked characteristics. In the first place, the tendency of the disease is to affect males in a greater proportion than females, but the affection is usually transmitted through the mother, she being frequently a member of a myopathic family, although not herself affected. Several members of one family may be affected, and in such an event the boys usually suffer while the girls escape. The disease commonly manifests itself between the ages of five and six, not that some signs of the disease cannot be detected if looked for earlier, but the unusual weakness in the child is at this age first observed. Although the above is the age at which the onset of the disease is most common, cases occur not only in the second and third decade of life, but also during the fourth. Three-quarters of the cases, however, occur before the age of ten years. The cause of the disease is unknown.

Symptoms.—The first symptom usually noticed is that the child frequently falls, and is then unable to get up from the ground without help. On the other hand, the difficulty with which the child goes upstairs is that which often first attracts attention. It is rarely that the enlargement of the calf muscles is the first point to attract notice, although on examination they are often found to be enlarged. In a typical case of the disease it is usual to find certain muscles hypertrophied, hard, and firm, while others are atrophied or absent. The muscles most commonly hypertrophied are the calf muscles, one of the muscles of the quadriceps group, sometimes the vastus internus, sometimes the rectus, the glutei, the infraspinatus, the deltoid, and the triceps. The muscles which are most commonly atrophied are the costal and sternal portions of the pectoralis major, the latissimus dorsi, the biceps, the serratus magnus, the flexor muscles of the thigh, and the extensors of the leg. The atrophy of the two lower portions of the pectoralis major and the hypertrophy of the infraspinatus is especially characteristic of the disease. The muscles of the face are rarely affected; the masseters are sometimes enlarged, and the tongue is occasionally enlarged. The position assumed by the patient when standing and when sitting is very characteristic. When standing the trunk is held erect, and there is marked lordosis; when, however, the patient assumes the sitting position the lordosis is converted into a marked kyphosis. The gait is also very striking; it is waddling in character, the weight of the trunk being swung vertically over the head of one femur, while the other leg is swung forward without being raised from the ground to any extent by the flexors of the thigh. If any obstacle comes in the way so that the patient has to raise the foot, great difficulty is experienced in so doing, and this weakness is specially obvious when the patient attempts to go upstairs. When a child affected with this disease attempts to mount the stair, support is first taken from the balusters, with this arm fixing the trunk, the one leg is swung laterally on to the stair above, and then brought to a position in immediate front of the patient; a hand is now placed on the knee, and the weight of the trunk is partly thrown forward, and partly pulled forward by the arm which is holding on to the balusters, and by this means the leg becomes again extended, and the step is accomplished. This performance is again repeated for the next step. Often the patient cannot even accomplish this, and various devices are adopted, such as going upstairs backwards, climbing up the balusters with the arms and dragging the legs after. The difficulty which these patients exhibit in rising from the floor is a most characteristic feature of the disease. If the patient be laid on his back on the floor he cannot sit up straight away by flexing the trunk on the thighs, but he rotates himself by means of his arms on to his face. He now flexes the legs and places himself in a kneeling position, the shoulders being supported by the arms and hands on the ground. The legs are now extended, and the feet are gradually brought nearer the hands, the head being placed well down between the arms, so that a large part of the weight of the trunk is supported by the arms. The position is now such that the patient is standing with the trunk bent forward and supported by the hands on the ground, and the final stage of the manœuvre is to raise the body on the thighs. This is done by the process known as "climbing up the legs," the hands being placed first on the leg, then on the thigh, thus elevating the trunk into the erect position. Certain deformities are met with in these cases. There is often some spinal curvature due to the weakness of the muscles of the back. The feet, owing to the contraction of the calf muscles, tend to assume a position of equinus, and at the same time the foot becomes inverted. The electrical excitability of the muscles is greatly diminished both to the faradic and galvanic current; there is never any reaction of degeneration. There is no affection of the bladder or rectum. The superficial reflexes are, as a rule, preserved; the knee-jerks are generally lost early, but this depends on the condition of the quadriceps extensor, and especially on that of the vastus internus. The progress of the disease is slow; when, however, the patient loses the power of walking, weakness tends to increase rather rapidly. The final stage of the disease is one of atrophy and contraction. It should, however, be mentioned that the disease sometimes runs its whole course without any hypertrophy; the cases, however, still have distinctive features, viz. the atrophy of the lower portion of the pectoralis major and the comparatively large infraspinati. Death is generally due to some pulmonary affection.

(3) *Facio-Scapulo-Humeral Type* (*Landouzy-Déjerine*).—This disease tends to affect both sexes alike, and is transmitted either by male or female. The age of onset is subject to great variation, some cases occurring in earliest childhood, while others have come on in middle life. The following description taken from a mother and son who were affected gives a fairly good idea of the type:—The first thing that was noticed wrong was that the child when nine months old slept with his eyes open at night. When about two years old, having learnt to walk, it was noticed that he could not blow a toy trumpet unless the corners of the mouth were held, and that whenever he was taken out in the wind the tears ran down his cheeks; for this latter affection he was treated by the slitting up of the canaliculi. The child learnt to walk at the ordinary age, but was always thin. The child first came under observation when five years old, and the appearance of the face was very striking; it was expressionless and almost motionless, the mouth was long, and held slightly open. The frontalis could not be moved; the eyes could be closed with exertion, but the slightest pressure of the finger was able to prevent this and to open them when closed. The teeth could not be shown, and a smile was only indicated by a slight downward movement of the corners of the mouth. The cheeks could not be blown out, and the child could make no attempt to whistle. The tongue could be well protruded; the palate acted well, the masseters acted powerfully, and the ocular movements were good. The appearance of the shoulders, as seen in the mother in whom the disease was more advanced, was striking. They were sloping, and the upper angle of the scapula could be seen from the

front projecting midway between the tip of the shoulder and the line of the neck. The patient could not raise the hand to the head except by swinging it round to the back of the neck, and then "climbing" on to the head. There was great weakness of the serratus magnus, as manifested by the marked "winging" of the scapula when the arms were put out in front. There was wasting of the whole of the trapezius, the rhomboids, and the latissimus dorsi, but the infra- and supraspinati, and the deltoids were well developed, the biceps and triceps were weak, and the pectoralis major was also affected. The muscles of the forearm and hand were well developed and strong. The muscles of the trunk and neck are only involved late in the disease. The muscles of the leg most commonly affected are the glutei and the muscles of the thigh; the peronei muscles are sometimes affected. Like all the other forms of this group, the muscles show no reaction of the degeneration on electrical examination, but simply a relative decrease. There is no alteration in sensation, and no affection of the sphincters. The course of the disease is extremely slow. A child in whom facial weakness is present may show no marked weakness in the limbs till nearly twenty years old, and even then the progress of the disease is so slow that by thirty-five he is still able to keep at work. Often the disease seems to come to an absolute standstill. The knee-jerks are present so long as the quadriceps remains good.

Pathological Anatomy.—The pathological anatomy applies to all the types included under the heading Idiopathic muscular atrophy and hypertrophy. It may be stated that no lesion can be found either in the spinal cord, the anterior or posterior roots, the peripheral nerves, or in either the finer motor or sensory fibres passing to the muscles. The muscles alone show any pathological change, although it must be mentioned that Babes has shown that changes exist in the motor end plates.

The muscles to the naked eye appear either pale and resemble a mass of fat, or have a brown, firm, and hard appearance. On section of a muscle it is seen that there is a great increase of the connective tissue, not only between muscular bundles, but also between the individual muscular fibres, so that individual fibres become surrounded by a ring of connective tissue. Some of the fibres are atrophied, others are hypertrophied, often being twice the normal diameter, but all have an almost circular outline on section. In between these muscle fibres fat becomes deposited. The muscle fibres are in some instances extremely atrophied, but even when reduced to a very small diameter they still retain their transverse striation. A few of the fibres may show some fatty degeneration, and some may be vacuolated. The walls of the vessels are thickened. A very striking feature in some of the muscles is the number of muscle-spindles that can be seen in cross section of a muscle in a given area. In the normal muscle these are not, as a rule, very obvious, but owing to the atrophy which has taken place in the muscle fibres (the muscle-spindles remaining unaffected) the relation between the two has become altered.

Pathology.—The fact that no change has been found in the nervous system, and that the change is almost limited to the muscles, is strong presumptive evidence for regarding the disease as primarily of myopathic and not myelopathic origin. The condition of the muscle, however, viz. the hypertrophied fibres, is not in itself incompatible with a nervous origin, for an exactly similar condition is found after a purely spinal lesion, and the suggestion made by Erb that it is possibly a trophoneurosis is one which should not be too summarily dismissed. That one has not to do with the spinal affection of the cells of the anterior horns is clearly shown by the distribution of the muscular atrophy, since this follows no segmental distribution, but one which according to some authors follows rather a developmental order. There is, however, one point about the examination of the muscles themselves which may throw some light on the origin of the disease. It has already been noticed that the muscle-spindles form a very striking feature in transverse sections of the muscle. Now it is known that these structures are connected with nerve fibres of a sensory nature which pass up in the posterior roots, and it is also known that in such conditions as infantile paralysis, progressive muscular atrophy, these muscle-spindles do not atrophy. Now if it could be shown conclusively that these muscle-spindles exist unaltered in muscle which otherwise had undergone complete atrophy, then it would seem probable that the disease must depend on some lesion situated at a point where the course of the motor and sensory fibres lay apart, *i.e.* somewhere above the posterior root ganglion. The question is not, however, easily answered, for it has been shown by Sherrington that the muscle-spindles only very slowly undergo atrophy after its nerve-supply is cut off, and again the number of cases of myopathy in which special attention has been directed to this point is very limited.

Diagnosis.—The diagnosis in a typical case is not difficult. In the pseudohypertrophic type the enlargement of the calves and infraspinati and the atrophy of the pectoralis major; in the facio-scapulo-humeral type the affection of the face, and in the scapulo-humeral type the atrophy of the upper arm and thigh, are features which are sufficiently striking to render the distinction of the types easy. From other forms of progressive muscular atrophy of spinal origin they are usually distinguished by the slower and more gradual onset, by the absence of all fibrillary tremor, by the distribution of the muscles affected, and by the absence of the reaction of degeneration on electrical examination.

Treatment.—The patient should be encouraged to keep at exercise as long as possible. When once the patient ceases to walk the disease seems to make more rapid progress. It is important that the patient should perform regular muscular exercises, both active and passive (see Physical Education and Therapeutics). Warmth and massage improve the circulation, and probably do some good, and lessen the tendency to muscular contraction. No drug exercises any influence upon the disease.

10. PERONEAL TYPE OF MUSCULAR ATROPHY.—This form of muscular atrophy has certain points in common with the myopathic form of muscular atrophy just described. But although it is here described under the heading of a muscular affection, it is in all probability primarily a spinal rather than a muscular disease. For the present, however, it is most conveniently described in association with the myopathic rather than the myelopathic affections.

Ætiology.—The disease is an hereditary and familial affection, in some cases being traced through five generations, and affecting numerous brothers and sisters in the same family. Males suffer rather more frequently than females. The influence of the acute specifics on the incidence of the disease would seem to be marked, and this is especially so in the sporadic cases. The age at which the disease usually manifests itself is before ten years, but a good many cases also occur during the second decade of life.

Symptoms.—The first symptom of the disease generally manifests itself in the legs. There is a tendency to drop the foot and also to turn it in. This weakness is due to the wasting of the extensor longus hallucis, the extensor communis digitorum, and the peronei muscles. The disease may start in one leg first, but is usually symmetrical. The small muscles of the legs being successively involved, and finally the muscles of the hand and foot are also affected. The atrophy passes gradually up the leg, so that the distal portion of the muscle atrophies before the proximal, and those muscles more distally situated before those more proximal. When the disease has invaded the thighs this gives to them "the bottle-shaped appearance." As the disease advances the small muscles of the hand are next to be affected, giving rise to the typical "claw hand," the atrophy later extending to the flexors and extensors of the wrist. Even when the legs below the knee are atrophied to an extreme degree, it is remarkable how well the patients get about, and are even able to ride a bicycle for miles. In addition to muscular atrophy, there is very marked vasomotor change in the condition of the limbs, the feet being always blue and cold. Alteration of sensation has also been described, and pain has been present in some cases. Muscular tremor is present in some muscles. The knee-jerks are long preserved, and even when the atrophy below the knee has become extreme, they are still obtainable. The disease is very slowly progressive, although in a child in whom the first symptoms began after measles it was only eighteen months before the hands began to show signs of atrophy, and by that time the atrophy below the knee was extreme. The electrical excitability of the muscle is greatly diminished, so that often no reaction can be obtained either to faradism or galvanism of ordinary strength. Reaction of degeneration may be present.

Prognosis and Course.—The course of the disease is extremely slow, and death only results from some pulmonary or other complications.

Pathology.—The pathology of this disease is still uncertain. The changes that have been described are an increase of the interstitial tissue in the peripheral nerves, and a similar condition in the postero-median columns of the spinal cord. All observers are agreed that, apart from the changes of the posterior columns, no change can be found in the spinal cord or in the cells of the anterior horn. The distribution of the disease, affecting as it does the periphery of the limbs, strongly suggests a nervous lesion, and the occurrence of fibrillation, the alteration of sensation, and the occasional presence of the reaction of degeneration all point to the same direction. The occurrence of the disease in families indicates that there is a congenital tendency to premature failure in the lower neurone, and those which are longest seem most prone to suffer. That severe affections of the nervous system sometimes follow measles is well recognised, and that it should produce this particular form of disease in certain families and individuals in whom there is already possibly some congenital tendency to its development, is easily understood.

11. An Hereditary Form of Progressive Muscular Atrophy in Young Children.—The disease here described has only of late years obtained general recognition. The cause of the disease is unknown; but it often affects many members of a family, and those independently of sex. The age at which the disease first makes its appearance is about the tenth month of life; other cases have developed somewhat later. There is, however, reason to believe that the disease sometimes makes its appearance shortly after birth, and runs a progressive course in the first few months of life.

Symptoms.—An apparently healthy and intelligent child who has made normal progress till the tenth month of life begins without any sudden onset or known cause to lose power first in the muscles about the pelvis, and then in the muscles of the back, so that the child who has been able to sit up in its cot is no longer able to do so. The disease pursues a progressive course—the shoulders, the thighs, the upper arm, the forearm, and feet. No special group of muscles is affected, the wasting being general. Fibrillary twitchings of the muscles may be present in some cases. The limbs are wasted and lie absolutely flaccid. On electrical examination the reaction of degeneration is often present. The deep reflexes, and sometimes the superficial, are abolished. There is no disturbance of sensation, and the sphincters act normally. The mental condition remains unimpaired throughout the whole course of the disease. Bulbar symptoms sometimes make their appearance, and from these the child may die; but since the intercostal muscles are often affected some pulmonary complication generally causes death. The disease usually runs its course in from three to four years.

Pathological Anatomy.—The brain, cerebellum, cranial nerves and their nuclei are normal. In the medulla and spinal cord atrophy of the cells of the anterior horn is a marked feature. Changes are found in the anterior roots, and also in the peripheral nerves. Changes are also present to a slighter degree in the lateral columns of the cord. The muscles are degenerate, some fibres having undergone simple atrophy, others waxy degeneration, and others again granular degeneration. Hypertrophied muscle fibres exist at certain points, and there is an increased amount of connective tissue and fat.

Diagnosis.—Considering the child's age the disease is most likely to be mistaken for rickets, the child becomes flabby, loses its power of sitting up, and lies more or less helpless in its cot. The absence of all signs of rickets, the diminished excitability of the muscles of the leg, the absence of the knee-jerks, and the absence of tenderness, all point to some nervous affection. From an early form of myopathy the disease will be distinguished by its more rapid course, the absence of all electrical change, and also by the fact that the atrophy is general.

Prognosis.—The disease is steadily progressive, and usually runs its course in from three to four years.

Treatment.—No treatment has been found of any avail. Massage and electricity may be tried, but much cannot be expected from them.

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Muscles, Traumatic Affections of.—The muscles, though not easily injured, may suffer from contusions and strains. In consequence of such there is usually pain and temporary impairment of function of the muscle, but in the absence of other more serious injury, such as dislocation or fracture, recovery is usually rapid and complete.

Rupture of Muscle is not a common occurrence. It is probably never due to voluntary muscular contraction, but is either occasioned by external violence or by a sudden violent unexpected muscular contraction, with the result, if the tendon be not separated from the muscular belly, or from its attachment to the bone, that the muscular fibres are themselves torn through. In rare instances muscles have been ruptured in the violent tonic spasms of tetanus. The extent of muscular substance involved in the laceration is very variable. In many instances of partial rupture, where only a few fibres are lacerated, the clinical condition is indistinguishable from a strain. Complete rupture, where the whole muscular belly is torn across, is a more serious condition. Such injury is most common in the rectus abdominis, rectus cruris, adductors of the thigh, soleus, pectoralis major, biceps, deltoid, and triceps; whilst in the gastrocnemius partial rupture is more common.

Muscles are more liable to rupture when they are the seat of any pathological process which reduces their elasticity, as, for example, the degenerative change seen in the late stages of typhoid fever. Although striped muscle has some power of proliferation, the ruptured muscle is united almost solely by fibrous tissue, and yet the movements dependent upon the contraction of this muscle may be but little impaired.

Symptomatology.—The individual who by some sudden instinctive muscular effort or otherwise ruptures a muscle experiences a sudden sharp pain likened to the blow of a whip or a stone, whilst there is a sense of something having given way. On examination of the injured region, the conditions found depend mainly upon whether the ruptured muscle be superficial or deep. If the former, one may find hæmorrhagic discoloration of the skin together with a swelling indicating the effused blood. Or one may determine the presence of a depression between the two halves of the ruptured muscle. On attempting such a movement as is due to the contraction of the injured muscle, the movement cannot be performed, or is defective, and the two portions of the muscular belly become prominent on either side of the soleus which was already felt. In cases of deep-seated rupture all these local signs cannot be determined, and the diagnosis must be based chiefly on the character of the pain and loss of function. It is often difficult to differentiate between laceration of a few fibres of the erector spinæ and lumbago. For a considerable time after repair is complete there is local stiffness, weakness, and often pain on contraction of the muscle.

Treatment aims at approximating the torn muscular surfaces and retaining them at rest in that position for a period varying according to the severity of the injury, but lasting five or six weeks in the case of a complete rupture. For a considerable time afterwards the patient should employ hot fomentations, massage, and moderate exercise. If there be complete rupture of some important muscle, an early operation to unite the portions of torn muscle will probably be advisable.

Wounds.—After union of the divided muscle by operation it is to be kept in a relaxed position till union is complete, just as in the treatment of rupture.

Hernia of Muscle.—In consequence of rupture of the sheath, part of the muscular belly, when it contracts, will pass through the aperture in the sheath and form a hernia. Continued relaxation of the muscle, or the pressure of a firm bandage, will as a rule effect a cure.

Myalgia. *See* MUSCLES.

Myasthenia Gravis.

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Synonyms.—Asthenic bulbar palsy, Bulbär paralyse ohne anatomischen Befund, Myasthenische paralyse, Myasthenia gravis pseudo-paralytica, Malattia di Erb, Erb-Goldflam symptom complex, Hoppe-Goldflamsche Krankheit, Allgemeine schwere Myasthenie, Asthenie motrice bulbo-spinale.[1]

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[1] A nomenclature which classes this disease with the various forms of bulbar palsy is to be avoided, since it is apt to give a quite erroneous conception of the nature of the disease. Myasthenia gravis is not a bulbar affection, but a general disease of the voluntary motor apparatus; although it is true that many of its most striking symptoms are undoubtedly bulbar, it is rare to meet with a case in which the muscles of the extremities and trunk escape. Further, in exceptional instances, in the early stages of the disease at least, the limbs alone may be affected.

Definition.—A disease which is characterised by muscular weakness and by the facility and rapidity with which the muscles become exhausted, as the result both of voluntary and faradic stimulation. Some or all of the voluntary muscles may be affected. The muscular weakness varies in degree and is unassociated with atrophy. The onset of the disease is usually, though not always, insidious. Although, as a rule, the disease shows a tendency to pursue a progressive course, remarkable variations in the intensity of the symptoms are apt to occur from time to time. A large proportion of the recorded cases have ended fatally, a sudden attack of asphyxia having frequently been the cause of death. No changes have been discovered, post mortem, to account for the symptoms. No specific treatment is known for the disease, though palliative measures are valuable.

In the most recent editions of English textbooks no mention is made of myasthenia gravis, or at most a few lines are allotted to its description. Although undoubtedly a rare disease, it seems certain that myasthenia gravis occurs more frequently than is commonly supposed; its extreme rarity is probably more apparent than real, and due to the fact that many cases are not diagnosed. Since myasthenia gravis is often fatal, since it is often mistaken for hysteria, and since its recognition may be the means of averting a fatal termination, the disease assumes an importance out of all proportion to the frequency of its occurrence.

Historical.—In 1877, Wilks reported a fatal case of bulbar paralysis, in which, although a careful microscopical examination of the medulla was made, no pathological lesion was found. In 1878-79, Erb drew attention to several cases of what he called "a new symptom-complex, probably of bulbar origin," and remarked upon the course of the disease, the presence of ptosis and of weakness of the neck and jaw muscles as points distinguishing it from the ordinary form of progressive bulbar palsy. Oppenheim, who in 1887 described a case of chronic progressive bulbar paralysis without post-mortem "findings," drew attention to the absence of muscular atrophy and of corresponding electrical changes. In this case the pons, medulla, cranial nerve roots, spinal cord, tongue and hypoglossal nerve, the right biceps muscle and the nerve branches entering it, were examined microscopically, but nothing abnormal was met with.

Hoppe, in 1892, by analysing the symptoms which the cases of Wilks, Eisenlohr, and Oppenheim presented, materially contributed to the recognition of the disease as a distinct clinical entity, and he was the first writer to suggest a toxic origin for the disease. Goldflam, in 1893, pointed out the ease with which the muscles become exhausted by voluntary effort, a fact not hitherto insisted on; he also showed that the disease was curable (temporarily ?). Jolly, in 1894, demonstrated the myasthenic reaction, which will be described later. Strümpell, in 1895, reviewed the literature and collected twenty cases which had been reported up to that time. Some eighty cases have now been placed on record.

Etiology.—Males and females suffer almost equally. Although the disease may occur at any age, it is most common between 20 and 40, women being attacked at a somewhat earlier age than men. A neuropathic history, either in the patient himself or in his family, was present in about a quarter of the recorded cases. No instance has been reported in which two members of the same family have been affected with the disease. Four or five times, the presence of some congenital abnormality (unilateral ptosis, a bifurcated uvula, an extra digit) has been noted, a point on which Oppenheim lays considerable stress in reference to the pathology of the disease. No class of society is exempt, although the disease appears to be rather more frequent among manual workers. Five of the recorded cases occurred in teachers. Not infrequently the symptoms have followed upon an infective disease (influenza, typhoid, scarlet fever, etc.). Anæmia was present in several cases. In five or six instances the patient was subject to megrim, while more than once Graves' disease has been noted as a complication. Muscular over-exertion is not uncommonly mentioned as a cause of the disease. The onset of menstruation, a confinement, a chill, emotional excitement, an attack of diarrhœa, and acute intestinal obstruction have been blamed in individual cases.

Symptomatology.—The most prominent feature of this disease is the facility with which the muscles become fatigued by voluntary effort. The term *myasthenic state* seems applicable to this phenomenon. A voluntary movement which is at first perfectly carried out, becomes rapidly feebler each time it is repeated; finally, if persisted in, *all* power of performing the movement may be lost; after a short rest the movement can be again performed with almost as much power as on the first attempt. A variable degree of persistent paresis is often present in the affected muscles. This paresis is usually slight, but sometimes amounts to a complete paralysis (*e.g.* complete ophthalmoplegia externa), and probably represents a more advanced stage of the myasthenic state, in which the recuperative power of the neuromotor apparatus is especially impaired.

Although the disease sometimes develops suddenly, a gradual mode of onset is the rule. Usually the initial symptoms are referable to one or two groups of muscles. As the disease progresses, it shows a tendency to affect all the voluntary muscles to a greater or less extent.

In many cases, the external ocular muscles are the first to suffer; hence the ptosis and diplopia which so commonly occur as early symptoms. In some cases the weakness first appears in the limbs; in others, difficulty in articulation, in mastication, or in deglutition, first attracts attention.

In pronounced cases of myasthenia gravis, the facies is pathognomonic. The face is mask-like and expressionless. The immobility of the lips when the patient speaks is very striking. Bilateral ptosis is usually present, though often slight in degree. Not unfrequently the movements of the external ocular muscles are defective; occasionally there is complete ophthalmoplegia externa.

Very characteristic alterations in speech occur. As the patient continues speaking, his speech becomes nasal, his articulation indistinct, and he requires to take a breath after every two or three words. Finally, speech may become quite unintelligible.

Weakness of the jaw muscles renders mastication difficult or impossible. Difficulty in swallowing is a source, not only of inconvenience, but of grave danger to the patient, for in a considerable number of the reported cases death was due to an attack of choking. Because of the palate weakness already referred to, nasal regurgitation is apt to occur when the patient drinks. Inability to support the head, a common symptom, is accounted for by paresis of the neck muscles.

The muscles of the extremities nearest the trunk are usually most affected. The paresis is not always equal on opposite sides of the body. Patients often complain of weakness in the arms, especially at night when undressing, or when brushing the hair. Weakness in the legs necessitates frequent rests when walking. If he tries to hurry, the patient speedily becomes breathless. Apart from the dyspnœa which results on exertion, attacks of breathlessness and cyanosis are apt to occur without apparent cause, and may prove fatal. Strümpell attributes these attacks to falling back of the tongue. Palpitation is not uncommon; in the cases which have come under my notice in which this symptom was complained of, it was always associated with dyspnœa or flatulence.

The above description of the symptomatology of myasthenia gravis refers more particularly to those cases of the disease in which the symptoms are pronounced. In slight cases, the patient, during the earlier part of the day, both feels and looks in his usual health, and the symptoms only appear towards evening. This increase of the *myasthenic state* as the day advances forms one of the most striking features of the clinical picture. In very severe cases the patient may be bedridden, unable to walk more than a few steps, and unable to sit up for more than a few minutes at a time; in some cases the weakness is so great that he can only turn in bed with difficulty.

Various conditions intensify or aggravate the symptoms of the disease, and of these, emotional excitement is one of the most important. Females are usually worse at the menstrual periods. Cold also increases the readiness with which the fatigue symptoms appear. But quite apart from any known or obvious cause, great variations in the intensity of the myasthenic state are apt to occur.

So far no mention has been made of the way in which the myasthenic muscles respond to electricity. Just as varying degrees of motor weakness are met with, so, corresponding variations in the faradic excitability of the muscles occur. It is, however, the rapidity with which the muscular contractions diminish in response to faradic stimulation which is especially characteristic of this disease; the term *myasthenic reaction* has been given by Jolly to this condition. When a tetanising current is applied to an affected muscle, at first an active contraction is obtained, but in the course of a short time the muscle ceases to respond. If the electrode is removed from the muscle and reapplied after a short interval, a good contraction is again obtained. The myasthenic reaction is not constantly present; at one time a muscle can be exhausted in half a minute, at another time it may be impossible to exhaust it. The myasthenic reaction, although not absolutely pathognomic of the malady, is a diagnostic sign of great value.

The muscles react normally to galvanism. Little or no difference is produced in the muscular contraction as the result of constant and repeated stimulation by the galvanic current. After the faradic excitability of the muscle has been exhausted, a good contraction may still be obtained by galvanism.

An analysis of the few reported cases of myasthenia gravis in which muscular atrophy was present, raises doubts as to whether true muscular atrophy ever occurs as a symptom of this disease. In some of these cases the diagnosis is doubtful quite apart from the presence of muscular atrophy. Indeed, with the exception of a case reported by Laquer, in which extensive muscular atrophy followed upon the symptoms of myasthenia gravis, there does not appear to be a single undoubted case on record in which there was any marked degree of atrophy. It is quite possible that in this very exceptional case, the muscular atrophy was a complication due to some additional etiological factor, while it seems probable that the slight degree of atrophy met with in other cases, may have been the result of muscular disuse. In none of the ten cases which one has personally examined was atrophy present.

The deep reflexes are usually rather brisk. In three cases the activity of the knee-jerk was seen to diminish after repeated tapping of the patella tendon. There is nothing abnormal as regards the skin reflexes. The plantar reflex is of the flexor type.

Although a feeling of fatigue and aching in the muscles is sometimes complained of, objective disturbances of sensation are not met with in myasthenia gravis. The mental state is unimpaired. The special senses are unaffected. There is no derangement of the bladder or rectum.

Pathological Anatomy.—Nineteen cases have been examined post mortem; in the majority of these cases no pathological lesion was found in the nervous system or other organs of the body.

In several cases, small hæmorrhages have been described around the vessels in the medulla and central grey matter. That these hæmorrhages were not responsible for the symptoms, but due rather to the asphyxia which was the cause of death, seems probable for the following reasons:—

Firstly, Although hæmorrhages were noticed in the neighbourhood of the nerve nuclei, the nuclei themselves were not involved to any great extent.

Secondly, The distribution of the hæmorrhages was not in accordance with the symptoms present during life.

Thirdly, The hæmorrhages were of quite recent origin.

Pathological changes in the medullary nuclei and anterior horn-cells have been described in two cases. In the case described by Murri, the changes were so slight as scarcely to warrant the term pathological, more especially since the post-mortem was delayed until six days after death; while the chromatolytic changes described by Widal and Marinesco in their case may be readily accounted for by the febrile condition present for some days before death.

Changes suggesting a congenital defect of the nervous system were present in three cases. Thus Eisenlohr found a number of small fibres in the hypoglossal and some of the other motor nerve roots, while in two other cases there was a double central canal. The upper motor neurons, peripheral nerves and muscles, when examined, have shown no pathological changes.

N.B.—Since this article was written a fatal case of myasthenia gravis has been described by Déjerine and Thomas (*Revue neurologique*, 15th Jan. 1901, p. 3), in which the following conditions were met with on histological examination:—A diminution of the nerve-cells in parts of the cerebral cortex (*e.g.* the left ascending frontal convolution). The cell-bodies which persisted were reduced to rounded masses or to nuclei clothed with a thin layer of protoplasm. The neuroglia in this area was markedly increased. Scattered degenerations were found among the pyramidal nerve-fibres in their course through the bulb. The muscles of the tongue and larynx showed fatty degeneration, and the nerves supplying them were similarly affected. The nerve-fibres of the tangential and projection systems appeared normal. No lesions could be found in the internal capsules, cerebral peduncles, basal ganglia, bulbar or spinal nuclei. Further observations are required to confirm the constancy of these changes.

The following associated lesions have been met with in the other organs in individual instances, viz.:—Enlargement of the spleen; chronic interstitial nephritis; parenchymatous nephritis; miliary tubercle of the kidney; pulmonary tubercle; a caseous bronchial gland; a sarcoma of the anterior mediastinum; myeloid sarcomata of the ribs associated with albumosuria, and, in a few cases, some enlargement of the thyroid gland. It is true, as Oppenheim remarks, in referring to these lesions, that they are morbid processes capable of introducing a toxic substance into the blood. But the total number of cases is so small and most of the above-mentioned changes so common, that it seems scarcely justifiable to lay much stress on their existence as playing a part in causing the disease.

Pathology.—In the absence of a visible lesion to account for the symptoms, the seat of the lesion must of necessity remain a matter for speculation. Since the disease manifests itself exclusively by motor symptoms, the morbid process is in all probability confined to the motor neurons or to the muscles themselves. The suggestion that the lesion affects primarily the sympathetic system (Collins) seems to have little to support it. To regard the purely motor character of the symptoms as favouring an affection of the muscles as opposed to the nerves is clearly inadmissible, since certain diseases of the nervous system are known in which the symptoms are purely motor, and in which the lesion is confined to the motor neurons.

The manner in which the myasthenic muscles respond to faradic and galvanic stimulation suggests an affection of the nerves rather than of the muscles. It has been shown in at least one case of myasthenia gravis that, if the muscular contractility is exhausted by faradism, a good muscular contraction can still be obtained by the direct application of the galvanic current to the muscles—the inference being, that it is the nerve-endings and not the muscular fibres which are actually functionless. The effect of emotional excitement in aggravating the myasthenic state, and the occurrence of sudden attacks of dyspnœa, give support to the nervous origin of the disease.

Further, it must be remembered that no disease of muscles is yet known which is unassociated with structural changes in the muscles themselves, while functional diseases of the nervous system are frequent.

Although it is not possible, absolutely, to exclude the muscles, the bulk of the evidence is in favour of the nervous system being the seat of the lesion. It may be that both the upper and lower neurons are affected in varying degree. The flaccid nature of the paresis, the diminished faradic excitability which is sometimes present, the myasthenic reaction, the attacks of dyspnœa and choking, all point to an affection of the lower as opposed to the upper neurons.

As to the nature of the morbid process :—

In many respects the myasthenic state resembles an exaggeration of normal physiological fatigue. It seems to me that the phenomena of the disease are best explained on the assumption that there exists an unstable condition of the motor neurons, as a result of which their capability of functional activity is reduced, so that they become exhausted more readily than in health, while their recuperative power may be at the same time diminished.

Possibly this "condition" of the motor neurons is dependent upon a congenital "defect" in the neurons themselves. A more probable view would appear to be that a toxine, produced in the body consequent upon some defect of metabolism, induces this condition in the motor neurons. It is quite possible that, in the future, accurate observations on metabolism may throw some light on the pathology of myasthenia gravis.

Impossible as it is, with the facts which we possess, to dogmatise upon the nature of this hypothetical poison, the view that it is of endogenous origin, and that it acts by operating continuously upon the neuromotor apparatus, producing a relapse only when the vitality of these parts is sufficiently low for it to get the upper hand, appears in the present state of our knowledge to be the most reasonable.

As has been already mentioned, in about a fourth of the recorded cases the first symptoms have appeared after an infective illness. When one considers the frequency of the infective diseases, the rarity of myasthenia gravis, and the comparatively small proportion of cases of this disease, in which the symptoms have followed upon an infective illness, it seems probable that the preceding malady acts in these cases by lowering the vitality of the organism rather than by producing a toxine which is the actual cause of the disease.

Diagnosis.—When the symptoms are well marked, the diagnosis is easy, but the recognition of slight cases may be a matter of considerable difficulty.

The following are the chief points upon which the diagnosis is to be based :—

Firstly, The presence of muscular weakness, which is often slight in degree, and is unassociated with atrophy or spasticity ; the muscular weakness varies in intensity from time to time, and tends to affect in varying degree all the voluntary muscles—the muscles of the extremities and trunk as well as those innervated by the cranial nerves.

Secondly, The facility with which muscles become exhausted both by voluntary effort (myasthenic state) and by faradism (myasthenic reaction).

Thirdly, The absence of sensory symptoms apart from the fatigue of exhaustion, of sphincter trouble, of disturbance of the special senses, and of a neurotic temperament.

Early cases of myasthenia gravis, in which the symptoms are only slight, are usually taken for *hysteria*, a mistake which is largely accounted for by the varying intensity of the symptoms—a feature common to the two diseases. Points of especial importance in the differential diagnosis between myasthenia gravis and hysteria, are the absence of an hysterical temperament and of sensory symptoms in the former disease; while ophthalmoplegia externa, facial paresis, weakness of the neck muscles, and the myasthenic reaction are symptoms which, when present, help to confirm the diagnosis, since they are rarely if ever present in hysteria.

More advanced cases of myasthenia gravis are to be distinguished from the different forms of bulbar palsy for which they are commonly mistaken. The more important features which distinguish myasthenia gravis from *chronic progressive bulbar paralysis* are, the age of the patient (chronic progressive bulbar paralysis almost always occurs in people over forty years of age), the absence of muscular atrophy and fibrillary tremors, the frequent involvement of the eye muscles, and the intermittent character of the symptoms in the former disease.

From those rare diseases *chronic superior bulbar palsy* and *polioencephalomyelitis* the differential points already alluded to, viz. the absence of atrophy, the intermittent character of the symptoms, etc. are usually sufficient to allow of a diagnosis being made. Kalischer, Koschewnikoff, and others, however, have described cases in which the differential diagnosis between myasthenia gravis and polioencephalomyelitis was very difficult. Since muscular atrophy was present in these cases, Oppenheim believes either that they were not cases of myasthenia gravis, or that the muscular atrophy was a complication and not a direct result of the disease. No post-mortem has as yet been made on an undoubted case of myasthenia gravis in which muscular atrophy was present, and in the meantime one is disposed to accept the view which Oppenheim takes.

In *apoplectic or acute bulbar palsy*, the result of a vascular lesion, the onset is more sudden, and the tendency is for gradual improvement to occur. The lesion usually involves some of the sensory nerves, producing sensory symptoms, while paralysis of the limbs if present is most frequently unilateral and of the spastic type, *i.e.* associated with increased deep reflexes on the affected side, the Babinskitve phenomenon, etc. Ultimately atrophy follows in the muscles supplied from the affected nuclei.

In a similar manner other *bulbar* lesions, such as tumour, softening, abscess, etc. are usually attended with symptoms indicating the implication of sensory structures; the symptoms are rarely symmetrical, and if paresis of the limbs is present it is of the spastic type.

The absence of muscular atrophy suggests possible difficulty in differentiating myasthenia gravis from *pseudo bulbar paralysis*, and the absence of a nuclear lesion post mortem supports this supposition. As a matter of fact, the diagnosis between the two diseases is not a difficult one. The onset in pseudo-bulbar paralysis is usually sudden, and the tendency is for gradual improvement to take place, while if there be paralysis of the limbs, it is generally hemiplegic in distribution and of the spastic type.

Mention has been made of the resemblance in physiognomy between the *myopathies* and myasthenia gravis, but this resemblance is only superficial. The involvement of the ocular muscles, the absence of similar cases in the family, the presence of the myasthenic state and myasthenic reaction, and the temporary improvements in myasthenia gravis place the diagnosis beyond doubt.

Prognosis.—Of sixty cases collected and analysed by Harry Campbell and myself, twenty-three ended fatally. The average duration of life *in the fatal cases* was about a year and a half after the development of the first symptoms.

It is inadmissible to lay too much stress, however, on deductions drawn from the recorded cases; without doubt these figures give an exaggerated impression as to the fatality of the disease, as will be seen from the following considerations. In the first place, the number of cases is not great; secondly, the nature of several of the cases was not recognised until the post-mortem, when the absence of a discoverable lesion to account for the symptoms drew the observers' attention to the unusual nature of the condition; and, thirdly, it is certain that many non-fatal cases have passed unnoticed, the majority having been in all probability diagnosed as hysteria.

Although a year and a half has been the average duration of life in the fatal cases, in some instances the symptoms have been present for a very much longer period. Dreschfeld's patient, for instance, suffered from the disease for fifteen years.

Death has been known to occur in fourteen days in one case, while in several the total duration of life after the disease first appeared was under six months. Sometimes remarkable improvement takes place, and the symptoms may entirely or almost entirely disappear for months or even years.

It is probable that complete and permanent recovery sometimes takes place, but since the majority of reported cases have only been recently observed, time must elapse before it is possible to speak dogmatically upon this point. In fatal cases, the end is usually sudden and often quite unexpected—a fact which should be borne in mind when giving a prognosis. It is particularly in those cases in which attacks of dyspnœa occur that a fatal result is most to be feared.

Treatment.—Although no specific treatment is known, much can be done by palliative measures. Since the severity of the symptoms is greatly influenced by the psychic state of the patient, it follows that mental excitement of every kind is to be avoided. The beneficial effect to the patient of a favourable prognosis cannot be too strongly emphasised. Although his friends should be informed, the patient must not know of the gravity of his condition. The patient must forego muscular fatigue in any form; more particularly is this important as regards the parts chiefly affected by the myasthenic state. If there is much weakness, absolute rest in bed should be insisted on. It is important that the patient be warmly clad, since cold increases the severity of the symptoms. If there is much weakness in the muscles of mastication and deglutition, the greater part of the daily nourishment should be taken early in the day, as the myasthenic state becomes more pronounced towards evening. Solid food should be thoroughly minced, in order to spare the muscles of mastication, and to obviate the risk of choking. If the patient is unable to swallow the requisite amount of nourishment, he should be fed per rectum rather than by the œsophageal tube, for in one recorded case the passage of the stomach tube brought on a fatal attack of asphyxia.

As regards electrical treatment. Faradism should not be used, as it actually does harm by fatiguing the muscles. Galvanism has been extensively employed, but it cannot be said that any certain beneficial results have followed its use, although Goldflam attributes the improvement in his cases largely to this mode of treatment. It is very doubtful whether massage has any beneficial effect.

Hitherto drugs have been found of little value in the treatment of this disease. Strychnine has been used in a number of cases both by the mouth and hypodermically, but no definite improvement has followed its use. Negative results have followed the use of glucose, potassium iodide, mercury, veratrin, physostigmin, and suprarenal extract. Thyroid extract, employed by Buzzard in one case, was followed by great improvement from the day the drug was first given, but later a relapse occurred, and although this patient stated that he improved whenever he was taking the thyroid, it is open to question to what extent the effect was a psychical one. In another case in which thyroid was given, there was no improvement.

Arsenic and iron appear to do good, probably by their general tonic action.

It seems possible from theoretical considerations that inhalations of oxygen and infusion of saline fluid may be of use in the attacks of dyspnœa and cyanosis which are accompanied by general increase of the myasthenic state. Strümpell states that the attacks of dyspnœa may be relieved by pulling forward the tongue.

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Mycetoma.

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MYCETOMA, a fungus foot (Carter), is common enough in parts of India, and particularly in Madura, in the Madras Presidency; in other districts occasional cases also occur. A few instances, five in number, have also been met with in America, two of the patients coming from Texas; it seems probable that cases have hitherto been overlooked, and mistaken for tubercular caries or elephantiasis. Only one case has occurred in Europe (Bassini). As the poorer classes in India are nearly always barefooted, the fungus probably finds its way into the part by some wound or fissure, especially as thorns are excessively common in the fields, and even the thick skin of the sole is frequently penetrated. In by far the larger number the foot is affected, but the disease also occurs in the fingers and palm of the hand, occasionally spreading upwards to the forearm. All the patients I have seen have been natives of the country, and so far as I am aware, the disease has not been met with in an European; the latter wear boots, and are not likely to be in the fields except for shooting or soldiering purposes. The big toe is very frequently the earliest seat of the disease, and, unfortunately, the sole may also be primarily attacked; very rarely does the disease extend above the leg, but I have met with it in the knee and thigh as high as the apex of Scarpa's triangle. There is, of course, no reason why any part of the body should not be affected provided the fungus be introduced. The researches of Drs. Kanthack, Boyce, and Surveyor show that the fungus is allied to that of actinomycosis.

There are three varieties met with, named from the appearance of the peculiar bodies found either in the discharge or in the tissues.

1. *Black Variety.*—The bodies are black like grains of coarse gunpowder.
2. *Yellow Variety.*—The bodies resemble seeds, grains of smokeless powder, or fish roe.
3. *Red variety*, in which the colour of the particles is orange or red like grains of Cayenne pepper. This variety is less frequently met with than either of the others, while the black variety is most common of all.

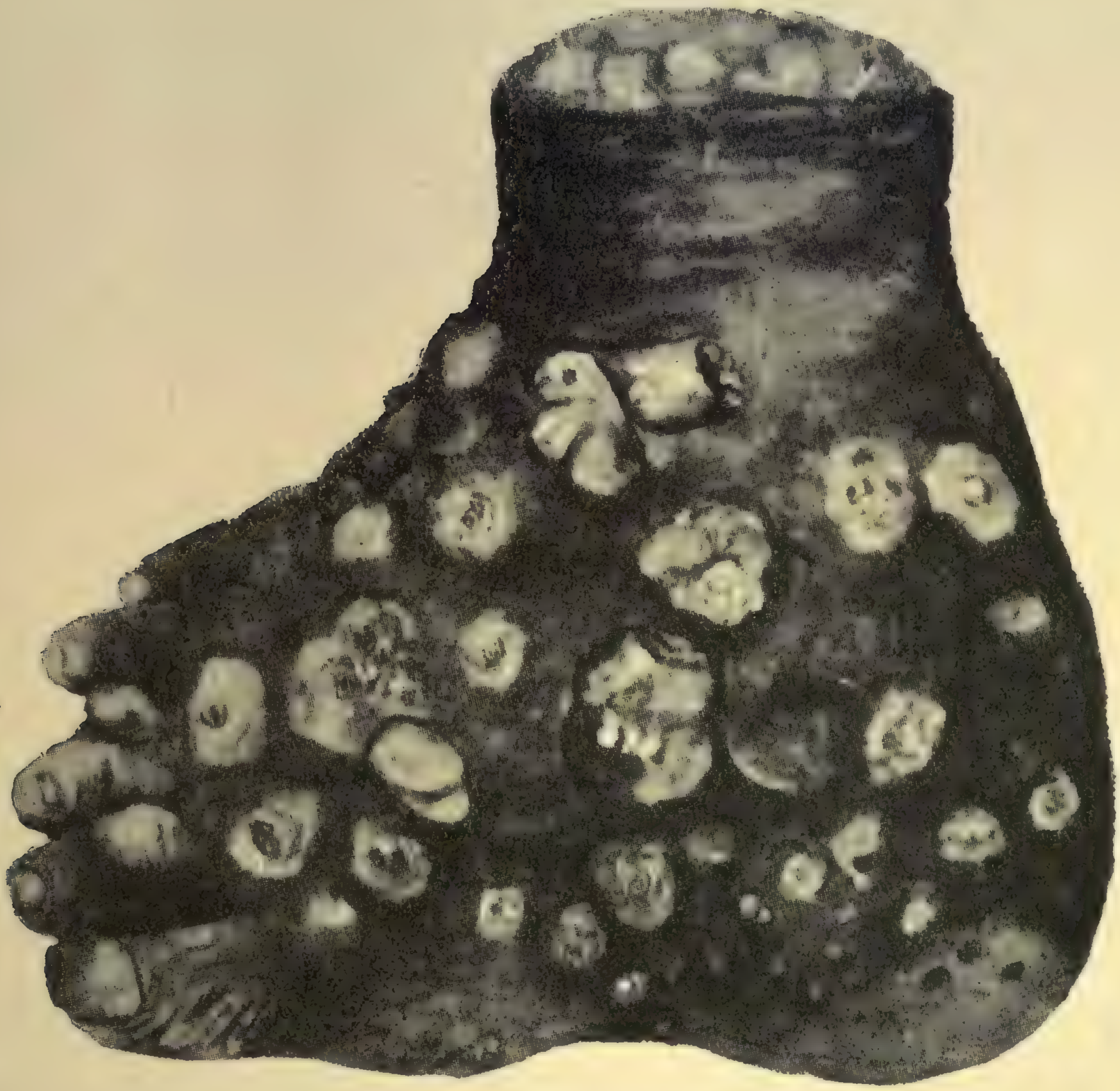
Symptoms.—The attention of the patient is usually attracted by swelling of the part, which, if it be the big toe, appears thickened, and has probably on the under surface one or more small swellings which burst, and from which a purulent discharge issues, and on careful examination some of the characteristic bodies can generally be detected in it. As the disease advances the whole foot becomes gradually enlarged and misshapen, the dorsal and plantar surfaces become more and more convex, the toes are gradually shortened and buried in the deformed foot (*see* Figure); numerous fistulous openings now form, but sometimes there are a few only; also rounded elevations about the size of a sixpenny piece are met with; these are usually darker than the surrounding surface, or may be yellow in colour. If very numerous they give almost the appearance of a tubercular eruption, having the shape and sometimes the size of a limpet; in the centre of these the fistulous opening is frequently found, but many are unbroken. If the swellings be opened the black or yellow bodies may be found in them. There is, as a rule, little or no pain present, but the patient complains of the increasing weight and the weakness of the foot when placed on the ground; at a later stage, however, when the bones are involved, a good deal of pain may be complained of, and if the sole is markedly convex, as it soon becomes when early affected, the difficulty of walking is very much increased. On palpation the tissues feel firm, brawny, and inelastic; in parts, however, there may be areas rather softer than the rest, and occasionally fluctuating. The fistulous openings are small, and surrounded by discoloured areas frequently black or yellow in colour, and occasionally small granulations protrude. If the probe be introduced it can be made to pass through the diseased tissues until the bone is reached; through this it can be pushed with the greatest care, and a sensation of grating is imparted. If the bones have become much softened the arch of the foot is destroyed, and very little weight can be placed upon it. Some time usually elapses before this stage is reached. There is seldom any fever, nor does the general health suffer except in cases of great severity. When, however, abscesses form in the soft parts, as in the muscles of the calf, the patient becomes feverish, emaciated, and has the usual appearances of septicæmia. The glands become secondarily affected and more or less enlarged; they are found on microscopic examination to be infiltrated by the fungus, the femoral glands, and occasionally those around the external iliac artery have been found diseased.

When the disease commences in the sole of the foot a small indurated area is first noticeable, which gradually extends, while openings subsequently appear upon the surface. In the early stage it is frequently extremely difficult to diagnose between inflammatory changes likely to be produced by the introduction of a foreign body into the sole, for which, in fact, it is usually mistaken by the patient. The plantar surface becomes gradually bulging, and so unfortunately interferes at an early period with locomotion, preventing the patient from carrying on his work, hence he is likely to seek advice before the disease has markedly advanced. Under these circumstances, except from below, the appearance of the foot, as a whole, is not appreciably affected for a considerable time, and the dorsal surface may, in fact, appear perfectly normal and the toes unaltered. Owing to disease of the extremity the calf muscles waste, and thus the size of the foot becomes still more marked. Little or no movement of the digits can be made by the patient when the disease is advanced.

Similar changes take place in the hand, the bulging of the palm is most conspicuous, and the openings on both surfaces are usually numerous, the roots of the fingers are much enlarged, while the fingers themselves appear shortened. As no weight is placed on this part, as in the case of the foot, pain is only slight or practically absent.

Pathology.—The changes in the tissues are so marked and peculiar that it is not surprising that several different views were put forward to explain their causation, that is before the fungus was discovered. These changes are undoubtedly due to chronic inflammation and degenerative changes set up by the presence of the fungus.

The skin is thickened and tough on section, the underlying tissues are replaced by granulation tissue, fibrous, and fatty structures, the muscular fibres having more or less entirely disappeared, and even the plantar and palmar fasciæ and tendons gradually metamorphosed and destroyed; but portions of the muscular strata can generally be detected. The thickness of the parts is much, and in some cases enormously increased. In the substance of these tissues are numerous nodules, varying in size from a pin's head to that of a pea or larger, and in these the characteristic particles, black, yellow, or red, can readily be discovered. Some nodules may be broken down, soft and caseous in character, or small abscesses are formed between the layers of tissue. The bones, when much diseased, are extremely light and porous, similar nodules are found scattered throughout their substance: if these are removed round cavities are left connected together by fine channels; the whole bone may be tunnelled in various directions as if bored by some insect, the bone itself is friable, red in colour, and easily perforated by the probe. The shape of the individual bones is very slightly altered. Their articular surfaces are seldom ulcerated as in caries, nor is there usually effusion between them. On section masses of fungus are frequently found immediately beneath the cartilage. When the muscles are large like those of the calf, abscesses containing purulent fluid and a quantity of roe-like bodies are frequently met with in the intermuscular spaces.



In leprosy the bones are also light and porous, but the round shot-like cavities are absent, and the bones, particularly those of the phalanges, much attenuated.

As long ago as 1874, Dr. Vandyke Carter gave a close and accurate description of this disease, which he rightly attributed to a vegetable fungus, but did not succeed in detecting the real organism. Later, Bassini, Kanthack, Boyce, and Surveyor made careful observations microscopically, and established the fact that the disease is due to a Ray fungus; they differ, however, in some particulars, and Boyce and Surveyor are of opinion that there is more than one variety of fungus present. The fungus appears to be allied to that of actinomycosis; so far as I am aware, no instances of mycetoma have been described occurring in cattle, whereas in actinomycosis this is common enough. The particles of the yellow variety exhibit under the microscope a central mass readily stained by aniline dyes, while peripherally there is a zone of radiating filaments, also club-like processes, which too stain deeply with aniline dyes, and fatty crystals are also present, and sometimes calcareous and phosphatic crystals and black particles containing iron. The central mass is described by Kanthack and others as consisting of a network of mycelial filaments. In order to cut sections, the best method (Surveyor) is to embed in paraffin, and before dissolving out the paraffin to fix the section on a slide with Mayer's albumin; this prevents the roe-like bodies from falling out. From the roe-like bodies a streptothrix has been cultivated by both Boyce and Vincent; it is aerobic, and grows well on potato saturated with alkaline nutrient broth, also on glycerine, agar. They did not, however, succeed in communicating the disease by inoculation.

Dr. Carter considered the black variety to be a degenerate form; Kanthack also was unable to convince himself that this variety was of a vegetable nature. The pigment is difficult to remove, but the application of eau de Javelle and hypobromite of soda will enable the fungus to be satisfactorily demonstrated; this fungus is described as a "septeto aspergillus," and cannot be found in the pale varieties. So far no spores have been discovered, nor has cultivation been successful. The red variety has not yet been thoroughly examined, the colour can be removed by spirit, but no fungus has as yet been made out.

Diagnosis.—When the disease is advanced there is little difficulty to any one who has met with cases before, and the discovery of the roe bodies in the discharge will confirm the diagnosis absolutely. It is not, however, always possible to find them, and particularly in the early stage when the disease is confined to a toe or portion of the sole or palm; it is by no means easy to arrive at a conclusion. Under these circumstances it is justifiable to incise the tissues and search for the diagnostic particles. The diagnosis lies between mycetoma and local inflammation, especially that due to a foreign body, tuberculous disease, and elephantiasis. If a foreign body is suspected it may be possible to feel it with a probe, or on examination after incision an X rays may be made use of; this will expose either the foreign body or the characteristic seed-like particles of mycetoma. In one patient under my care a piece of a bradawl near the wrist joint gave rise to appearances similar both to tuberculous caries and mycetoma. In tubercular disease the openings are few, granulations are usually present at the surface, the digits are mobile, and there are no seed-like bodies or tubercles on the surface; grating, too, is often present. In elephantiasis there are no fistulous openings, the skin is thrown into folds near the joints, the muscles act freely, and except on the scrotum, tubercles are seldom met with; if present, they have a solid feel. A section of the tissue has a very different appearance; this is hypertrophy of the cellular tissue, which has a white gelatinous appearance, and fluid escapes freely.

Treatment.—So far I have not met with success by any other than operative measures, and these are very successful except in the case of the sole. Amputation will as a rule cure the disease completely, and if only a toe or finger is implicated, with little detriment to the patient. Unfortunately, however, it is seldom that the disease is caught in this stage, and hence the removal of the hand or foot is usually necessary. In the case of the sole the diseased area must be freely cut away, and carbolic acid may be applied; it is difficult or impossible to assure one's self that the disease has been radically removed, and the excision of a large portion of the plantar surface will cripple the limb very considerably. It is impossible to bring the edges of the wound together, and if, as is extremely likely, the tissues are more deeply affected than was supposed, the surgeon may have to consider the desirability of proceeding to amputation. I have found it, however, most difficult to get the patient to see the necessity of this, unless the bulging is so excessive as to make the foot both useless and painful. When, however, the sole is not especially affected, the patient is generally desirous of keeping the part until he can use it no longer; provided that the general health is not affected, and the disease not extended above the ankle, there is no harm in adopting this plan, but the glands must be watched. Recurrence in the stump has occurred after amputation, to my own knowledge, in two instances. When the lymphatic glands are enlarged it is safe to remove them, although the enlargement may be due to irritation only. Dr. Childe was able to demonstrate the fungus in the glands of the groin as well as enlargement of the abdominal glands. Occasionally the general condition of the patient may preclude the advisability of any operative interference whatever.

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Mycosis Fungoides. *See* SKIN, TUMOURS OF.

Myelitis. *See* SPINAL CORD.

Myiasis.

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MYIASIS (μυῖα, a fly).—The term "myasis" was invented by Hope in 1837 to indicate those disorders which originate from the accidental parasitism of dipterous larvæ. The form *myiasis* has since been adopted as more nearly etymologically correct. The larvæ of coleopterous and lepidopterous insects (beetles and moths) have occasionally been found as temporary inhabitants of the alimentary tract of man, but it is doubtful if they have ever caused serious symptoms. It is far otherwise in the case of maggots of flies, and the accidental parasitism of *dipterous larvæ* takes rank as an important section of parasitic disorders.

Distinction is made between intestinal and external myiasis.

MYIASIS INTESTINALIS.—This condition is caused by larvæ present in the alimentary tract, and introduced into the stomach (sometimes as eggs) with food. These larvæ, in the great majority of instances, belong to the order *Diptera*, family *Muscidæ.* In a series of a hundred cases the principal genera identified were—

1. Blow-flies and flesh-flies (blue, gray, and green-bottles)—*e.g. Calliphora, Sarcophaga, Lucilia.*
2. House-flies—*Musca*, etc.
3. Flower-flies—*Anthomyia*, etc.

The bluebottle flies and similar genera lay eggs (the largest only 1‴ in length) or larvæ, on meat, and these are ingested along with cold beef, high game, etc. The house-fly also (though usually laying its eggs on stable dung), often finds a nidus in meat which has begun to decompose. The eggs and larvæ of the Anthomyiidæ are found in vegetables and salads. The larva of *Eristalis*, the drone-fly, is sometimes found in drinking-water; *Drosophila* larvæ have been swallowed in sour milk or meat; and the common cheese maggot *Piophila casei* is too ordinary an article of diet to excite remark.

The *symptoms* of intestinal myiasis are not sufficiently defined to enable a diagnosis to be made before the larvæ have actually appeared.

Sometimes there are no symptoms complained of, and the extrusion of the larvæ is brought about by a sudden act of vomiting. Or larvæ may be noticed in the fæces, the host having been unaware of their lodgment within him.

But ordinarily "the presence of these insect larvæ is by no means harmless, and in proportion to their number and size they give rise to more irritation than the ordinary forms of intestinal worms properly so called" (Cobbold). This statement is fully borne out by clinical experience, and is readily understood when we consider their very active movements, the sharp appendages with which they are usually armed, and the great numbers which are often present. They may be evacuated in quantities too large for enumeration, and in individual cases have been estimated by the quart or litre. As a rule, grave symptoms are due to larvæ present in hundreds or at least in scores. But even very few may give rise to pain, profuse diarrhœa, or other distressing symptoms.

The history of a case of acute myiasis goes back to the particular occasion on which suspicious food was eaten. In general there is an interval of days, or even weeks, between this and the occurrence of symptoms. These at first are, as a rule, vague. There is loss of appetite, discomfort, headache, fainting, vertigo—perhaps a feeling of anxiety or oppression, or other nervous manifestation, *e.g.* reflex cough. After this "incubation" stage the complaint is aggravated. There is colic, nausea, and curious "suckings," "pinchings," or "throbbing" in the abdomen, with constipation or diarrhœa. Pain may become very violent, occurring in crises, situated often in the left side or epigastrium. Epilepsy may occur, or hæmatemesis. The onset of severe symptoms may be very rapid—"like a blow"—accompanied occasionally by rigors and fever. Relief comes suddenly and is effected by vomiting or by evacuation at stool, and the patient is rid of the parasites at the moment or in the course of a few days. The presumption is that this crisis is precipitated by the arrival of the larvæ at the full stage of their growth and development, and by the irritation they cause by their active movements and bristly appendages.

But though for the time the relief is immediate—and in acute cases permanent—in rare instances the symptoms may recur and the disease appear to take on a chronic character, although every possibility of reinfection has been excluded; the larvæ continue to be voided at regular or irregular intervals from stomach or intestine, each time with an interval of quiescence, a development of similar symptoms, and a conclusion by violent ejection. It cannot be said that death has occurred in consequence of *myiasis intestinalis.* Of two instances reported as resulting fatally, the first is given with too scanty detail to enable us to judge the relation of the myiasis to the fatal result, and the second has been misquoted owing to an error in Hope's tables, which located the larvae in the "stomach" instead of in the "skin." Death in this case was due to cutaneous, not to intestinal myiasis. That "chronic" myiasis may cause death in a weakly subject is, however, by no means improbable.

Myiasis is not frequently met with in the British Isles, but is not uncommon on the Continent and in America. This may be due to our less frequent use of uncooked foods, our greater freedom from swarms of flies, and our more temperate summers. But cases undoubtedly occur unrecognised or unrecorded, and the publication of any one of these is usually followed by a small series of reports by observers whose attention has thus been directed to the subject.

Little consideration is required to convince one that the eggs, if not the larvæ, of insects (notably those of flies) find their way into the human stomach in thousands of cases. For apart from eating uncooked or tainted foods, the ordinary precaution of covering cold meat with wire netting may be defeated by the bluebottle fly, which will drop its eggs through the meshes. Further, many races eat insects and their larvæ as delicacies, and even in this country, school children have been found who habitually eat cockroaches.[1]

It is equally certain that in most cases these eggs and larvæ, though exceedingly tenacious of life,[2] are destroyed in the digestive juices, and the dead eggs of the bluebottle are often found in the fæces.

But we are unable to solve the question why in some cases, and not in all, do these eggs and larvæ continue to live and develop after finding their way into the stomach. Experiments go to show that mere immersion in water for days will not always kill dipterous larvæ, and when introduced into the stomach of frogs and guinea-pigs they will live in a small percentage of cases for 12 to 72 hours—a period sufficiently prolonged to carry them into a less hurtful environment in the large intestine. On the other hand, I have found that larvæ of *Calliphora* (the blow-fly or bluebottle) do not survive artificial peptic and pancreatic digestion for more than six or seven hours, and that a dozen full-grown living maggots of the same species can be repeatedly swallowed without any symptoms resulting. Further, we have a number of recorded cases where larvæ, to the number of hundreds, have been, at one time, vomited from the stomach days after their first possible ingestion. In these cases they must not only have lived but also developed *in ventre*, since they could not have been swallowed when full grown on account of their size. It is not sufficient to suppose that the presence of gastric catarrh, or of other parasites, is the condition which determines the viability of larvæ inhabiting the intestinal canal, for about 25 per cent of cases furnish no history of such ailments. We can only say that some departure from normal conditions is necessary for their continued life in the gastro-intestinal tract of man.

Treatment.—In intestinal cases free purgation is generally sufficient to bring about evacuation of the larvæ and to cure the patient. Experiments with anthelmintic agents tend to show that attempts to kill the parasites *in situ* would generally be unsuccessful; and indeed in nearly all cases the larvæ have been evacuated alive. Large enemata, 3 to 5 pints, containing aq. chloroformi or turpentine, may be found useful, the effort being made rather to clear the colon than to kill the larvæ. Washing out the stomach has been successfully employed in recent years.

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[1] Anything is possible to a child. Buckland states that he met some boys who would swallow living frogs at a charge of ½d. apiece.

[2] Larvæ of *Teichomyza fusca* have survived about 40 hours' immersion in concentrated solution of alum ; *Eristalis tenax* larvæ lived 40 minutes in alcohol at 90° C. ; maggots of the blow-fly or flesh-fly will live 3½ hours in tinct. iod. and 3 to 5 hours in aqueous solution of the hydrg. perchlor. 1-1000.—*Lancet*, vol. ii. 1890, p. 690. Pruvot, Lallier, *l.c. infra.*

Causes of Error in Diagnosis.—Many of the older accounts of myiasis intestinalis are open to doubt on account of the credulity of the naturalists of the time. Even most cautious physicians have been deceived by the ingenuity of hysterical patients who have continued to swallow larvæ or insects in order to produce an apparent illness. When the observation is made by the patient error is very liable to occur. Larvæ supposed to have been voided are frequently discovered to have been deposited on the fæces after their evacuation, or to have been already present in the chamber used.

Many substances have been mistaken for new species of endoparasites, and have even received specific names. These have turned out to be portions of vegetable fibre or elastic tissue when subjected to a microscopical examination.

EXTERNAL MYIASIS.—It is convenient to consider three groups of cases: (1) Cutaneous myiasis; (2) myiasis vulnerum; (3) myiasis narium, conjunctivæ, etc.

1. *Cutaneous Myiasis.*—The eggs of already-hatched larvæ are laid on the skin, or in exposed wounds, ulcers, and sinuses, and in the discharges which may accompany diseases of the nose, ear, or eye. The larvæ live and develop in these situations. If the eggs have been laid on the skin the larva when hatched penetrates the integument, and living subcutaneously produces at first more or less irritation, then a suppurating tumour or boil in which the still living larva may be found, or from which it escapes by movements of its body, further development taking place outside its host. In Europe the larva of the ox bot-fly or "warble-fly" (*Hypoderma bovis*) is occasionally found under the skin of those engaged in tending cattle; cutaneous myiasis has also been traced to the bot-fly of the roe-deer and red-deer (*H. diana*). But such cases occur more frequently in America and in tropical climates, where, besides the above-named, larvæ of several species of the genus *Dermatobia* have in numerous instances been taken from suppurating swellings under the skin. In some localities the maggot of *Dermatobia* is known as *Ver Macaque.*

In South and East Africa the larvae of Ochromyia (*Ver de Cayor*) cause at times crops of boils nearly covering the body. Natives are probably immune. A species of the Œstridæ (*Œstrus hominis*) is said to have been differentiated peculiar to man, as *Œstrus bovis* is peculiar to the ox, but this is extremely doubtful.

Treatment of these conditions consists in squeezing out the larvæ, or by their removal with forceps, and healing follows rapidly with ordinary antiseptic measures.

2. *Myiasis Vulnerum.*—When eggs or larvæ have been deposited in wounds or ulcers, or in any of the external openings of the body, the case may become much more grave and difficult to deal with. In all probability some diseased, or at least foul-smelling condition of the part, is necessary to attract the female fly. These cases occur in the breeding time of the flies in question, *i.e.* in summer and autumn, and it is generally found that the patient has been infected while sleeping out of doors. A wound becomes "living," as it is termed, provided that the female of some species of blow-fly (bluebottle), or flesh-fly, has gained access to it for the very short space of time required to deposit her brood. The appearance of such a wound has been described by Summa:—

"To the naked eye such wounds appear as if beset with headless nails, which rise and fall with the extension and contraction of the animals while sucking. When the position of the larvæ is superficial we distinctly see their white bodies; the head sits with its hooklets in the bottom of the wound, which usually secretes no pus, but only a bloody-watery fluid, and has a bluish-pale, and after the removal of the animals a spongy appearance. The black hinder parts and the respiratory orifices are directed outwards."

Where wounds thus infected are neglected death may take place, but not before a horrible condition has been reached. Even in this country death has occurred from an invasion of maggots,[1] and a similar case was recorded in Paris in the year 1826. The end of the Emperor Galerius[2] and of Herod the Great and others, who according to old chronicles were "eaten by worms," was in all probability due to this cause.

3. *Myiasis Narium, Conjunctivæ, Vaginæ, etc.*—Here also some diseased or dirty condition is necessary to allure the fly. The chief species found depositing their young in these situations are again for the most part blue, gray, and green-bottle flies. Of this latter genus the maggots of the species *Lucilia hominovorax* are the best known, and by far the most destructive. In all cases where the nostrils, the ears, or the conjunctivæ have been the seat of oviposition, great swelling, pain, and fever occur. The maggots may wander to the frontal sinuses, or may gain entrance to the middle ear, or cause perforation of the cornea. The larvæ of *Lucilia hominovorax* (screw-worm) have the power of actually piercing through cartilages by means of their strong hooklets and the screwing movement of their body, and in the island of Cayenne, where the fly is best known to us, cases are very frequent and death far from uncommon. Severe mental symptoms may be caused by the disgusting nature of the malady when the maggots are found in the mouth or nose.

The diagnosis of the condition is not difficult when an open wound is exposed to view, and where the possibility of the occurrence is known. But when the larvæ are hidden in cavities of the body the inflammatory condition may be ascribed to other causes until the maggots themselves are seen. Thus Summa relates a case diagnosed as erysipelas of the face until a closer examination, which had been delayed on account of the horrible fœtor, revealed a perforation at the junction of the soft and hard palate in which numbers of maggots were lying. Injections of carbolic acid were ordered every half hour, the maggots were almost continuously removed all day by the patient's wife, yet the physician was able at one visit to take away fifty. The patient was convalescent in a few days.

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[1] "On Thursday, 25th June, died at Asbornby, Lincs., John Page, a pauper, under circumstances truly singular. This man used to prefer to tramp the country rather than to stay in the parish workhouse, and subsisted on the pittance he obtained from door to door. He usually received bread and meat, and it was his custom to deposit what he had not eaten between his shirt and skin. One day when he had a considerable portion of this provision in store he laid himself down in a field, and the day being very hot, the meat speedily became putrid, and was of course struck by the flies. These not only proceeded to devour the inanimate pieces of flesh, but also literally to prey upon the living substance, and when the wretched man was accidentally found he was so eaten by the maggots that his death seemed inevitable, and, in fact, the man survived the operation of dressing his wounds but a few hours." The date of this remarkable occurrence is not given, but Kirby adds: "In passing through this parish in the spring of 1814 I inquired of the mail coachman whether he had heard of this story, and he said the fact was well known" (Kirby and Spence, *Introduction to Entomology*). A similar story is told by M. Aristide Roger of the death of a Parisian chiffonier who having got drunk was found in a ditch outside the parish, still living, but with his features completely destroyed by the multitudes of blow-fly grubs feeding on him. In both these cases there were, no doubt, a number of sores, large or small, to permit entrance of the maggots, which could not otherwise penetrate the integument.

[2] "His death was occasioned by a very painful and lingering disease. His body, swelled, by an intemperate course of life, to an unwieldy corpulence, was covered with ulcers and devoured by innumerable swarms of those insects, which have given their name to a most loathsome disease" (Gibbon, *Roman Empire*).

Treatment.—Mechanical removal is of course indicated, and should be performed diligently. The most efficient agent for dislodgment or killing the larvæ, which are, as we have seen, extremely resistant to chemical agents, is chloroform; aq. chloroform of the B.P. being very effective. Turpentine is valuable where it can be applied, and naphthalin, thymol, and infusion of tobacco have been found useful.

INSECT STINGS AND BITES.—Among insects which attack man from revenge or fear we find many members of the *Hymenoptera,* and of these the species most commonly met with in our country are bees and wasps.

As a rule the sting of one of these insects causes no more serious effects than local pain and itching, accompanied by more or less swelling; but the effects are very variable, and it is not unusual to find general and much more serious symptoms resulting. Deaths from this cause are also frequently recorded.

The patient is usually an adult in good health, often a particularly healthy man. The sting is implanted on the exposed hands or face. Toxic manifestations occur within ten minutes' time or less, and the sufferer is brought to the point of death, or actually dies, in about twenty-five minutes from the time when stung.

The following symptoms occur in typical cases: Congestion of head and neck, accompanied by running from eyes and nose, increasing to cyanosis or deep lividity; swelling of throat and tongue (*even though sting be on hand*); slowing of pulse; embarrassment of heart and respiration; great itching of skin or pain all over body, especially perhaps in abdomen; vomiting; purging; erythema, or other rash; syncope. Recovery is usually rapid if the patient survive these symptoms for an hour or two. In twenty-four or forty-eight hours he is well; occasionally ill-health has resulted for some weeks or months. Septic or specific infection of the wound may occur in the process of stinging, and septic cellulitis or tetanus may result.

Dr. Julius Athans records glycosuria and epilepsy occurring after an interval of respectively "a few weeks" and "nine months" from date of injury, due in both cases, he believes, to the poison of the insect.

We do not yet know, in the case of a bee or wasp sting, what conditions determine on different occasions its greater or lesser toxicity. This does not depend on the patient's age, sex, previous health, nor on fear, though it may be aggravated by ill-health, or panic, or perhaps by idiosyncrasy. There is no evidence to show that the season or weather, or the food of the bee in question, has any modifying influence.

It has been alleged that lethal results are due to the entrance of the poison immediately into a vein, but this will not account for the majority of cases.

The immunity enjoyed by old bee-keepers is to some extent only apparent, and is in part due to their skill in handling, for every now and again one of the fraternity is brought to the verge of death by a single sting, although on a previous occasion the stings of fifty or a hundred bees may have caused him little trouble. This points clearly to the fact that *the nature of the poison* causing lethal and fatal results differs from the normal secretion of the bee.

The symptoms above related are not produced by the natural secretion; it is more likely that the powerful irritant poisoning of the nervous system (very comparable to the effect of snake bites) is caused by some substance of the nature of an animal alkaloid, and that this substance is present, either as the result of an admixture from without, or as a consequence of some disordered action of the physiological processes of the bee.[1]

Treatment in a mild case consists in carefully pushing out the sting so as not to squeeze the poison bag, and the immediate application of a weak solution of alkali, such as ammonia, soda, or lime.

The application of some antiseptic, such as carbolic lotion, or formic aldehyde, or permanganate of potash, is desirable, both as a means of breaking up the poison and as a preventive of septic sequelæ.

In more severe cases very free stimulation is indicated, strychnine in large doses, and ether, hypodermically; alcohol by the mouth freely; hypodermic injections of carbolic acid and permanganate of potash and cocaine locally. Tracheotomy may be necessary for *œdema glottidis*, especially if the sting be in the tongue or throat.

Cases of poisoning by wild honey have been reported in America and India. In one instance the lives of many persons were endangered, and two deaths actually occurred. The honey was subsequently found to be strongly impregnated with gelsemium.

Mosquitoes, Gnats, Gadflies, Household Insects, etc.—These insects have recently acquired a new importance in consequence of their relation to malaria.

Mosquitoes are sometimes imported into this country in ships' cargoes and personal baggage, and may be met with in London hotels frequented by American travellers. Dr. Thin (*Lancet*, 2/81/398) reports two severe cases of mosquito bite in London. In one instance the appearance of the face in consequence of the bites was like confluent small-pox.

In our own country and on the Continent, mosquitoes, gnats, gadflies, and many other species are sufficiently annoying, both by reason of their bites and stings and by their irritation when present in great numbers. In tropical countries and in the Arctic, travellers are subjected to great misery, from the attacks of a thousand species of Diptera.

Septic poisoning with more or less severe sequelæ has resulted from the bite of flies, as well as from the stings above mentioned. Very recently (*Lancet*, 9th Feb. 1901) a probably unique case was published, where a swelling developed on the forearm at the site of the bite or sting of a "green fly." Five months later the indurated swelling was removed, and was shown by microscopical examination to be a typical epithelioma of the skin.

When gnats or flies become numerous and troublesome in our houses, we can sometimes mitigate the nuisance by attacking their breeding-places—in the case of gnats, by cleaning neglected cisterns or water-barrels, by introducing fish into ponds, or pouring kerosene on the surface of collections of stagnant water; in the case of flies, by covering up or removing heaps of stable dung. Toads also may be found useful in this connection.

In the open air, nets form the most useful protection against mosquitoes, and complete immunity from bites can be ensured by their use. *Faute de mieux,* nets with a mesh of one centimetre, will be found useful; and open doors and windows may to a large extent be safeguarded with a mesh of even larger size, provided the light enters from this side of the room only.

Various substances applied to the exposed parts of the skin will ward off insects, even in Canadian, Norwegian, Arctic, etc., waters, where insect pests are innumerable and maddening, and these, though unpleasant, are gladly employed.

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[1] Calmette found that the poison of an individual snake varies in its activity, and is more virulent when the creature fasts.

The most trustworthy are: *Carbolic acid* (best in solution in oil, 1-10 or 15, as it is of use only while some part of the acid remains unevaporated by the heat of the skin, necessitating renewal at frequent intervals); *paraffin,* ʒj. to Oij. (this is irritating to some skins when much used); *clove oil* or *cinnamon oil,* ʒss. to spermaceti ointment, ℥j.; *cocoa-nut oil.*

These are all disagreeable prophylactics, but have been found preferable to the alternative plague of flies.

A weak infusion of *Quassia chips* (made in the cold) is said to be equally efficient, and would certainly be less unpleasant.

Treatment.—Eau de Cologne, carbolic lotion, and formic aldehyde (formalin and formal, etc.) applied to the bite or sting are the best-known remedies, but common soap well rubbed in for a few minutes, followed by a stream of cold water, is a handy resource which will generally give great relief.

Septic cellulitis may follow wounds caused by any insect.

The bite of Cantharis (the Spanish fly) may be followed by blistering. Conjunctivitis and great irritation of respiratory passages may occur in the presence of a number of the living insects.

Spiders in this country are not known to be hurtful to man by reason of the poison they secrete. The poisonous effects of tarantula bites have been enormously exaggerated. We have the authority of Gautier (*Les Toxines*), however, for stating that the malignant spiders of Elba, Corsica, Curaçoa, Madagascar, Venezuela, Russia, etc. can kill large animals and man. New Zealand possesses a poisonous spider which causes marked toxic effects, but a fatal result seldom if ever occurs.

The symptoms and treatment are much the same as in the case of wasp and bee stings. Cases of septic infection and tetanus through the use of cobweb as a styptic are occasionally recorded. Within recent years an extract of spiders has been used as a remedy in malaria.

Myriapoda, Scorpions, etc.—The sting of European varieties is comparatively harmless.

In hot countries the sting may cause alarming or fatal results, very similar to those described under bees and wasps.

The poison seems to vary considerably in power. Severe symptoms, however, occur in a large proportion of cases.

Treatment.—Ipecacuanha powder applied to the wound in form of a paste is the most widely known antidote. Chloroform stupes in addition will relieve the pain. The most efficient applications for the relief of both pain and swelling are chloral, 3 pts.; camphor, 1 pt.; menthol-camphor and similar combinations—the skin to be punctured with a needle and the remedies rubbed in.

Hypodermic injection of cocaine, gr. $\frac{1}{4}$-$\frac{1}{2}$, is said to give instant relief to the pain and to prevent subsequent ill-effects.

It is interesting to note that the ancient Persian treatment of scorpion stings consisted in "anointing the wound with the oil of these animals—extracted by frying."

Ants.—Indigenous species may be regarded as inoffensive except when occasionally they overrun our houses. It is often difficult in these cases to localise and destroy the ant-hills. Abroad they often constitute a plague both by the frequency of their bites and stings, and by their power of penetration through any substance except metal. "Willesden patent paper" is said to be impervious to them.

The "ants of visitation" (*Atta cephalotes*) are said by Kirby and Spence to be "so alarming and tremendous in their attacks, that if they enter the house in the night, the inhabitants are obliged to rise with all speed and run off in their shirts."

Travellers in tropical countries protect themselves when sleeping out of doors by a hair rope surrounding their sleeping-place. The ants, finding no secure hold on the long and loose hairs, slide or fall down, and try all night to find a less difficult place of entrance. The rope must be shaken each morning to dislodge any insects remaining in it, and replaced before dark.

In this connexion a curious case may be noted where post-mortem injuries, eventually found to be due to ants (staining and apparent bruising of skin), were attributed to ante-mortem violence.

Hairy caterpillars and other cetaceous larvæ are well known as causing skin irritation (urticaria, etc.) by contact with the skin. The irritation, swelling, and itching may be extremely severe, and may spread far beyond the parts actually pierced or poisoned by the sharp hairs and acrid secretions of the caterpillar's cuticle. The occurrence of a number of cases of this kind in a boys' school has given rise to difficulty, on account of the resemblance to an infectious epidemic.

Similar, though, as a rule, less severe effects are produced by certain hairy plants, such as the nettle, Primula obconica, arnica, mezereon, various species of rhus. In the glandular structures connected with the hairs, irritant substances have been isolated, "toxicodendric acid," etc.

Treatment is to be applied by alkalies and local sedatives, and removal of the offending cause when discovered. In Indian forests, where the caterpillar *Cnetho-campa processionea* is abundant, cloths require to be tied over the mouth and nostrils, for if hairs are inhaled, œdema of the throat may ensue.

Flies may act as Carriers of Infection.—This has been experimentally proved in the case of cholera. Observations have shown the presence of tubercle bacilli in the bodies and excreta of flies which have visited phthisical sputum; anthrax has been traced to the bites of flies from diseased carcases, and the purulent ophthalmia of Egypt is obviously transferred from eye to eye by the same agency.

The list might be prolonged, and it is clearly evident that the insanitary conditions of hot countries, together with the swarming insect life, must provide many illustrative instances.

Syphilis is less likely to be propagated, since the parts affected are in general covered up.

Father Damien attributed his leprosy to the inoculation by a fly of an abrasion of the scalp.

Infected flies may be chopped up with sausage meat, and thus disseminate disease.

It is stated that yellow fever can be transmitted by mosquitoes which have bitten a patient on the third to sixth day (inclusive) of the disease, and that in the case of one or two bites, only a benign form is transmitted. Preventive inoculation by this method has been suggested.

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Myopathies. *See* Muscles.

Myopia. *See* Refraction.

Myositis. *See* Muscles.

Myxœdema. *See* Thyroid Gland.

Nævus. *See* Electrolysis, Tumours.

Nails, Affections of the.

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As the scope of this article is mainly clinical and practical, a knowledge of the anatomy, physiology, and development of the nails on the part of the reader will be assumed (1). The point to be borne in mind is that the nails are specialised portions of the general integument or skin, and are liable to the same pathological processes.

The alterations met with affect the nails in their texture, shape, and colour. Usually all these modifications are present at the same time in varying degrees.

In rare cases the nails may be much thinner and softer than usual (*atrophy*), being sometimes reduced to a mere film (Wilson) (2). Or, again, they may be very brittle, splitting and crumbling as the result of slight injuries or when trimmed (*onychorrhexis*). Transverse furrows are of frequent occurrence, and the atrophic changes often give rise to a pitted worm-eaten appearance.

On the other hand, there may be hypertrophy of the hard nail substance (*onychauxis*). It is necessary here to distinguish true hypertrophy from the claw and horn-like formations (*onychogryphosis*—more correctly *onychogryposis*), which are really keratomata of the nail-bed, and in no sense a primary change of the nail proper (3). The subject of *onychogryposis* was first fully investigated by Virchow (4). In this condition the overgrowth is very marked, the nail becoming more or less discoloured, yellowish brown, or dirty looking; and assuming various shapes, sometimes looking like a great claw, at others being twisted like a ram's horn. The surface of the nails is ridged and irregular, and beneath them there are soft, dirty, evil-smelling masses.

Onychogryposis has been observed in a variety of conditions, which will be touched upon further on. Excessive overgrowth frequently occurs in old and bed-ridden people, especially affecting the big toes.

A true hypertrophy of the nail takes place in *acromegaly* (5).

The curvature of the nails over the ends of the fingers may be exaggerated, without hypertrophy or other change in the nail substance, and quite apart from clubbing. As far as shape is concerned the nails may be flattened, or depressed and concave on the surface (*spoon-nails—koilonychia*). The nails may also vary greatly in length, breadth, and so forth.

Or, again, the normal longitudinal ribbing, corresponding to the ridges of the nail-bed, may be accentuated or abnormally developed. In some instances there is a markedly raised median longitudinal ridge, the nail sloping away laterally on either side, like the roof of a house or a keel. This median ridge may divide towards the distal end, giving rise to a Y-shaped appearance. This has been observed in all the finger-nails of a patient otherwise well (6).

When the skin at the root of the nail coalesces with the latter and advances with its growth, a condition which goes by the name of *pterygium unguis* is attained.

The opposite change to this is very rare, viz. recession with exposure of the nail-root (*ficus unguium*) (7).

In cases where the nail has been badly injured it is gradually shed, a new nail meanwhile slowly forming beneath.

White spots (*leuconychia vel leucopathia punctata—flores unguium*, etc.) are often met with, especially in children or individuals with delicate nails, as a result of slight injuries. In rare cases transverse white bands have been met with (*leuconychia striata*) (8), or the leuconychia may be complete, the whole of the nail being affected (*leuconychia totalis*). In the latter the colour varies from an opaque, dead chalky white to a bluish-white. In some of the patients the etiology was obscure; in others the change was associated with various morbid conditions (9). In a case under Krieg and Weber (9A) some of the nails also exhibited the spoon-like deformity referred to above. As to the cause of the whiteness, it has been found to be due to air-bubbles finding their way into the interstices between the nail-layers, but Unna points out that this must be looked upon as a secondary phenomenon. In his opinion the main pathological feature is an abnormal softness, with swelling, of the nail-cells. This softness was very obvious in a case under his observation (10). In this patient the toe-nails were normal, but some of the hairs were white (*leucotrichia*). The finger-nails are more usually affected; but in Krieg and Weber's case the toe-nails were also involved, but to a less degree.

Unna (11) also describes another condition (*scleronychia*), in which the nails, from behind forwards are thickened, inelastic, hard, rough, and opaque, and of a yellowish-grey tint. This appears to be a pure nail disease, as the skin surrounding the nails and elsewhere about the body is quite healthy. Moreover, no constitutional cause can be discovered to account for the nail-changes (see further on, section xii., Anomalous and Obscure Affections of the Nails).

Nails may also appear in the wrong place, at times at the ends of amputation stumps (12).

In some cases of fracture of the long bones, the nails have been arrested in their growth (13).

The affections of the nails as they occur in practice will now be reviewed, together with rare conditions which may at any time come under observation. Various classifications have been suggested from time to time. In this place, however, the subject will be dealt with under general headings, a scheme which it is hoped will be found more practically useful for reference, although not strictly scientific. The ideal classification founded on Etiology is yet to seek.

I. Congenital.—Absence of the nails (*anonychia congenita*) is rarely met with, but cases have been recorded in which there was no trace of finger- and toe-nails at birth (see under section v. for an interesting case of the kind). At other times the nails may be extremely rudimentary, and more than one child in the same family may exhibit this anomaly (13a).

Various congenital malformations, such as supernumerary fingers and so forth, need not detain us. But brief reference to the following case may be made here, viz. an enlarged terminal phalanx, with an enlarged nail presenting a marked median longitudinal ridge, has been observed, indicating apparently a digital bifurcation (14) (or ? *syndactylia*). Brittle nails have also been recorded (*onychorrhexis*). For a complete account of congenital malformations the reader is referred to Heller's *Monograph* (15).

Congenital pemphigus (*epidermolysis bullosa*) is dealt with in section v., and *congenital syphilis* in section ix.

II. Heredity.—Various nail conditions have been found to occur in several members and generations of one family. White, opaque, longitudinally striated nails of the fingers and toes (? *onychia totalis*); the grandfather was said to have had white spots only (16). Family *leucopathia* of nails has also been observed by Lawrence (17).

D. W. Montgomery has seen hereditary shedding of the nails (18).

Nicolle and Halipré (19) found nail-changes running through six generations, no less than thirty-six members of the family being affected. The nails were more or less longitudinally ribbed, yellowish, flaky, and brittle; lateral ulcerations also occurred leading to the shedding of the affected nail. Mental diseases (the original patient was an idiot), hysteria, and so forth also ran in the family. An interesting point was that the hair was concurrently affected; it was thin, whitish, and easily pulled out. *Correlation of growth*, though liable to exceptions, is well known, and in a general way good, sound nails will be found going with sound teeth and strong hair. I have observed brittle nails associated with absence of the uterus in a young woman of 18. Her skin was dry (*xeroderma*), and there was little hair about the pubes; but the teeth were very good, and the hair of the scalp plentiful (see also Radcliffe-Crocker's Congenital Atrophy of Skin Case, section v.).

Spooning of the nails (*koilonychia*) has also been found in several members of one family. The finger-nails, and toe-nails too but to a less extent, were concave from before backwards in a woman, aged forty, and the deformity was stated to exist in her brothers and sisters; her father, his brothers and sisters; and also her paternal grandfather (20).

As to the nails in *psoriasis* and *epidermolysis bullosa*, see section v.

III. Injuries.—In this connection it is necessary to consider not only the nail proper, but also the matrix and nail-bed, with blood-vessels and nerves, in short the nail-organ, as it has been called. This remark applies to diseases of the nail generally.

Crushes and blows leading to sub-ungual hæmorrhages may result in the shedding of the nail, followed by a slow regeneration.

Cuts with sharp instruments through the nail may give rise to permanent ridges. When the root of the nail has been involved, the skin has been observed to coalesce with the nail, with a permanent irregular *pterygium unguis*-like condition.

The habit of biting the root of the nail, met with in neurotic individuals, results in exaggerated longitudinal ribbing, brittleness, transverse depressions and irregular protuberances, or loss of nail with regeneration. The thumb-nails are those usually involved, but several or all the finger-nails may be more or less affected. In such cases, too, the nails are discoloured, yellowish, or dirty looking.

Hæmorrhages into the nail itself has been observed as a result of injuries (21).

Röntgen Rays—The effects of the X-rays may be included under Injuries. Individuals habitually using and demonstrating the rays frequently present changes in the finger-nails. In a case which came under my notice all the nails, except those of the thumbs, were irregular, rough, and transversely furrowed. The condition is the result of the dermatitis induced by the rays, and when the latter is marked and recurrent the changes in the nails may be permanent. In mild cases the nails are stated to have slowly become normal again (22).

Occupation.—Various trades are inimical to the nails. Characteristic discoloration are seen in French-polishers, with other nutritional changes, as a sequence of the irritant dermatitis from which such workers suffer. In laundresses, housewives, barmaids, and others having their hands much in water or soda solutions, the nails become thin, irregular, brittle, and so forth. Lithographers, who use nitric acid, have rough, discoloured, and painful nails. Rayer has observed a recession of the skin at the root of the nails in curriers (*ficus unguium*) (23). (See also section v. under Eczema.)

Manicurists use a varnish which I have seen lead to redness and inflammation of the skin about the root of the nails, the latter becoming soft and brittle.

Among injuries, damage to the nails arising from *heat* and *cold* must also be mentioned (24).

Splinters under the nails may sometimes lead to permanent deformities.

I have also seen the nails greatly altered, and some of them practically destroyed from the indiscriminate therapeutic application of caustics in childhood.

IV. General Diseases.—The nails may be variously modified in a number of diseases. The curvature associated with clubbing of the finger ends in *phthisis* is well known. A similar condition, with cyanosis, occurs in *congenital malformation of the heart* (patent "undefended space") (25).

In *diabetes mellitus* shedding of the nails has been observed, and this quite apart from diabetic gangrene.

Subungual hæmorrhages occur in *scurvy.*

In *anæmia* (chlorosis), the pallor of the nails is sometimes very marked. There is no dividing line to show a lunula. This is a blood condition, analogous to the pale conjunctivæ, skin and mucous membranes. It must not be confused with *leuconychia totalis,* which it very much looks like at first sight.

Atrophy and brittleness of the nails have been seen is association with osteo-arthritis (26).

The nails have been shed in *enteric fever* (27).

It has been stated that reedy nails (*i.e.* marked longitudinal ridges) are significant of *gout.* I have certainly seen this condition where there was no gout; and, where gout was present, I found the patient had been in the habit for years of biting the skin at the root of the nails, sometimes to the quick. The fact is, this longitudinal striation increases with age. In young children the nails are normally smooth, but in old people ribbing is the rule.

Changes in the nails may be found associated with a number of other complaints, such as *rheumatic fever* and so forth, but these cannot be dealt with at further length in this place.

One interesting fact in connection with all prostrating illnesses is the transverse depression left as a memorial in the thumb-nails, for they show it best. This furrow slowly grows out in time, but its presence is an indication. By measurements, added to the knowledge of the average growth of nail, an approximate estimate of the time that has elapsed since an illness can be arrived at. A succession of alternate wavy ridges and furrows would point to recurrences and relapses.

V. Diseases of the Skin, including the Acute Exanthemata.—The latter diseases have been included in this group, as the nails in them become involved by continuity or proximity of the morbid changes occurring in the skin. They will be dealt with first and cleared out of the way. They are practically limited to two, viz. *small-pox* and *scarlatina*. As to the former, when pustules form about the nails, various changes may result. They may become rough, uneven, discoloured, or they may be shed and not regenerate. Locke, who was a medical man as well as a philosopher, refers to a condition of *onychogryphosis* as a sequence of variola (28). Papules may develop under the nail.

In *scarlatina* shedding of the nails and transverse furrows (29) have also been observed. Villaret, who records his own case, lost his finger- and toe-nails after an attack of scarlet fever, new nails gradually replacing the old ones in from three to six months (30).

Among diseases of the skin *eczema* of the hands and feet is one of the most common causes of alterations of the nails, especially when repeated attacks occur. In this group the so-called *trade eczemas* and *itches* find their place (barmaid's, bricklayer's itch, and so forth); they are now more usually alluded to under the heading of *irritant dermatitis.* Among such irritant causes arsenic must be mentioned. When this agent was used to preserve bodies for dissecting purposes, inflammation of the fingers and nail-matrices was of frequent occurrence among medical students (31).

In *eczema* the nail-changes observed vary greatly—thickening, thinning, pitting, dirty yellowish-brown discolorations, furrows, brittleness with splitting, and so forth. In severe, long-standing cases, associated with depression or mental stress, *onychogryphosis* may occur and prove very troublesome. Or, again, the nails may be reduced to mere horny, shapeless excrescences. In some patients more or less spooning may result (32), or the nail proper may be raised by subungual hyperkeratosis.

Hyperidrosis of the hands and feet is frequently found in eczematous conditions of the extremities. When the former has been of long standing, I have seen the nails thickened, with longitudinal ridges and transverse furrows and protuberances. The association of hyperidrosis and keratosis is also well known; here again nail-changes occur.

It is not uncommon to find the nails involved in *psoriasis*, either alone, which is rare, or with evidence of the disease in other parts of the body, which is usual. The changes in the nails vary in character, sometimes slight pitting only being present. In other cases the nails are thickened and discoloured, or onychogryphosis may occur (33). A common appearance is the loosening of the nail at the sides of its free border; it may be limited to the corners, but frequently it extends towards the root, down the sides of the nail, or the whole or the free border may be affected, more or less of the distal part of the nail being separated from its bed. One or more nails may be involved. Hutchinson considers the changes just referred to are characteristic of psoriasis; but Radcliffe-Crocker does not agree with him on that point. The latter observer has seen detachment of the nail down the sides where there was no evidence of psoriasis (34). I have examined the nails in a number of psoriasis cases, and I have met with a variety of changes. The gradual detachment of the nail from its bed, from the free edge towards the lunula, I have seen become more marked as the generalised skin eruption improved. Papules may develop under the nails.

In *pityriasis rubra*, one of the few universal diseases of the skin, which sometimes supervenes on a generalised psoriasis or eczema, nail-changes are constant—varying, of course, in degree according to the duration and acuteness of the inflammatory condition. Thickening, transverse furrows and ridges, shedding, and so forth, are observed. Similar changes occur in *pemphigus foliaceus*, which also involves the whole of the body.

The nails are sometimes affected in *recurrent desquamative scarlatiniform dermatitis*, and in the earliest recorded case (35) the nails were all thrown off, new ones taking their place in about six months.

When *scrofuloderma* occurs on the fingers round the nails, the latter may be elongated, with increased curvature, over the finger-ends, transversely ridged, uneven, dirty, and discoloured, with a tendency to onychogryposis.

In *leprosy* various alterations of the nails are observed. They are brittle, furrowed, reduced to amorphous horny masses, or they may come away entirely on some of the toes and fingers. The shedding of the big toe-nail may result apparently from the formation of a bulla about its root.

I have also noted symmetrical longitudinal ridging of the two ring finger-nails.

The nails are always affected in *epidermolysis bullosa* (*hereditaria*), sometimes called *congenital pemphigus.* They may be completely destroyed or reduced to small horny pegs. In other cases the nail may become separated from its bed, with thickening and also accumulation of dirty epithelial masses beneath, and this quite apart, apparently, from the occurrence of bullæ about the nail-roots (36).

Radcliffe-Crocker has recorded an unusual case of *congenital atrophy of the skin*, several features of which are of interest. The patient was a girl, aged five, born at full term with neither hair nor nails, but the latter began to grow a week after birth. The teeth, which appeared at the usual time, were sound and good. All the finger-nails and the big toe-nails were discoloured and almost black for about two-thirds of their length (36A).

In a case of *acanthosis nigricans* the patient developed white transverse bands in nearly all the finger-nails, as a result, apparently, of an intercurrent illness (37).

The nails may be shed or altered in their nutrition in *acute generalised alopecia* (*alopecia totalis vel universalis neurotica*).

Stone has described annual shedding of the skin and nails in a man of fifty. This had occurred regularly for several years (38).

Nail-changes have been noted in a number of other skin diseases, such as *pemphigus, dermatitis herpetiformis, sclerodactylia* (39) (*scleroderma*), *pityriasis rubra pilaris*, and so forth. For further particulars the reader is referred to these conditions in other parts of the *Encyclopædia Medica.* One point to remember is that different causes may lead to the same kind of nail-change, and various appearances in the nails may depend on one and the same disease. The continuity of the tissues should be borne in mind: the nails are part and parcel of the general integument.

(*Pellagra*, see section xv.)

VI. DISEASES OF THE NERVOUS SYSTEM.—*Nerves.*—As a result of injuries (gun-shot wounds, division, etc.) and disease (neuritis) of the peripheral nerves (40), nail-changes have been noted in association with glossy skin and muscular atrophy, such as increased curving, brittleness, furrows, atrophy, hypertrophy, onychogryposis, and even shedding.

The nails may also be altered in the condition known as *erythromelalgia* (Weir Mitchell) (41), which is included here, although there is still disagreement as to its exact etiology and pathology.

Spinal Cord.—Various changes in the nails have been noted in *tabes dorsalis, myelitis, syringomyelia* (see also section viii. Morvan's Disease), and so forth.

Sub-ungual hæmorrhages, followed by repeated shedding of the big toe-nails have been seen to occur in *disseminated sclerosis* and especially in *tabes* (42). In these cases the big toe-nails were symmetrically affected, but not simultaneously; they were rapidly replaced.

Brain, including Insanity.—Many observers have called attention to alterations in the nails in *general paralysis, epilepsy,* and so forth (43).

Mental Shocks.—Cases are on record where shock, great fright, and so forth have been followed by the shedding of the nails (44).

VII. ONYCHIA MALIGNA (Wardrop) (45) (*onyxis des scrofuleux*) (46).—Under this name Wardrop described a condition which commenced with marked swelling of a deep red colour of the soft parts at the root of the nail. Ulceration of the soft parts, with a thin ichorous discharge, occurs, leading to tumefaction about the end of the affected toe or finger. The nail loses its natural colour, its growth is interrupted, and in some places appears to have little connection with the soft parts. The pain is sometimes very great, but it may be absent. The big toes and thumb are most frequently affected, the patients being usually young. This condition is scrofulous in nature. It is uncommon, and there is no doubt that it has been confused with *syphilitic perionychia* (see section ix.).

VIII. WHITLOWS are a common cause of malformation and destruction of the nail. They may occur under the nail, or at its root or sides. Severe, neglected whitlows of the pulp of the finger, leading to destruction of the terminal phalanx, will naturally affect the nail in its shape and texture.

Among the changes I have noted as a result of a whitlow at the root of a nail, are irregular growth, with transverse wavy ridges and furrows, brittleness, and splitting when trimmed. Or a thickened median longitudinal ridge may form, with an indentation at the free end. Or, again, the nail may be slowly cast off, a new nail gradually taking its place.

In some cases recurrent superficial pustulation (irritation of thimble, etc.) may eventually give rise to longitudinal striations, protuberances, and so forth. In a case of this kind, going on for a year, about the root of some of the finger-nails, the latter had either been shed or had shelled off in flakes. The affected nails were brownish-yellow, thickened, with transverse furrows. The patient also suffered from *Raynaud's disease* (local syncope and asphyxia of several fingers), and the nails, which were not liable to the recurrent gatherings, were pitted, furrowed, and ribbed, with white spots; one nail presented a crescentic white band near the free end, with concavity forwards (*leuconychia.*)

Recurrent punctate suppuration in the nail-bed, usually affecting one finger, occurs in children, frequently according to Hutchinson (47).

Morvan's Disease (syringomyelia) may be included in this group. In this condition whitlows, painless in the great majority of cases, occur for years about the finger ends. The nails may be shed or altered in various ways (48).

IX. SYPHILIS (*psoriasis unguium* is a term sometimes improperly used for syphilis of the nail).

When the *primary chancre* occurs about the nail, the latter may be destroyed to a greater or less extent, or become permanently deformed, with irregular ridges and furrows, discoloured, and brittle, the more so as the syphilitic nature of the sore is often at first and for some time quite overlooked. The pain is described as being very severe, and this frequently leads to the erroneous diagnosis of whitlow.

In the course of syphilis papules may appear under the nails. Various changes have been observed, such as thinning and splitting; or the surface may become furrowed and discoloured, with superficial pitting and erosions (*onychia syphilitica*).

A more important condition is syphilitic *perionychia.* The rash may affect the neighbourhood of the nails, thus leading to disturbances in their nutrition. Or they may become affected by the extension of a tertiary palmar syphilide.

When ulceration with secretion of pus occurs it is more serious, as the nail may be destroyed, or at any rate shed, being slowly replaced by one of poor quality. In such cases there is usually swelling of the end of the affected toe or finger.

Congenital Syphilis.—Onychia and perionychia occurring in infants and children is suspicious of syphilis. One or more nails may be involved or shed, and the condition arise apart from any skin rash. In the *congenital bullous syphilide* both finger- and toe-nails may become uneven, discoloured, with crusts about the roots, and a red areola beyond.

X. PARASITIC DISEASES (exclusive of the Schizomycetes).—1. *Fungi. a. Onychomycosis* (*O. trichophytina-Tinea unguis vel unguium*).—Ringworm of the nail may be associated with the disease in other parts of the body, or the nails only be involved. One or more of these, either of the fingers or toes, may be affected. The condition is essentially a chronic one, and may date back several or many years, twenty (81), or more (49). The nails themselves are brittle, discoloured, of a dirty, brownish hue, rough, furrowed, and striated, with flaky surface. I have found it requires much patience in some cases to find the fungus in the scrapings. The back of the suspected nail should be scraped to a good depth with the sharp edge of a slide or with a knife, and the debris examined (with a high power) after prolonged soaking in liq. potassæ B.P. (about 5 per cent), or, better still, in a 40 per cent solution, which more rapidly clarifies the preparation. If no fungus be found at first, more liq. potassæ should be added, and the slide examined several times at intervals, when patience will be rewarded by the discovery of dichotomously branching and shortly segmented mycelial filaments, or chain formations may occur here and there or predominate. In my experience the fungus is large spored, but whether of the *ecto-* or *endothrix* variety cannot be definitely stated from the microscopical examination alone. A cultivation would be necessary to settle the point, but this has failed in two or three of the several cases I have examined. In one case, which was associated with *tinea circinata* of the back of the hand and phalanges, I found the megalosporon chain-like mycelium in a stump removed from among the hairs from one of the affected fingers. At the proximal end of the stump the fungus was outside (*ectothrix*), but higher up it was distinctly inside (*endothrix*) (49). The latter appears to be the usual fungus of *tinea unguium.*

According to Ehlers of Copenhagen, who first called attention to its fungus origin, an affection of the nails is common in Iceland (*kartnögl* from *kart* = card for combing out wool, and *nögl* = nail). It is really a *tinea unguium* contracted from sheep. One or two out of every ten peasants suffer from the complaint. All the finger-nails may be affected (50).

Tinea unguium may also be found associated with *tinea cruris* (*Eczema marginatum*) of eastern (Dhobie itch) and tropical or sub-tropical origin.

It is stated that in *tinea imbricata* the nails and hair are always spared (51).

β. Favus (*Onychomycosis favosa*).—The favus fungus may also attack the nails as well as the scalp and glabrous skin. It is usually contracted by auto-inoculation from other parts of the body; this is not to be wondered at when one considers that favus of the scalp may last for years. I have never seen the nails affected in London, where favus itself is rare, but it may become more common by importation through Jewish immigrants from Poland and elsewhere.

The nails are thickened, the surface irregular, and in some cases a yellowish tint is seen; or the surface may be fairly smooth or somewhat scaly. The nail itself is separated from its bed by a thick layer of friable substance; or there may be a heaped-up appearance. One or more nails may be affected. Microscopically the following are found: mycelial filaments varying in size, more or less ramified and segmented, with spores arranged in chains and in clumps (52). In a word, there is polymorphism of the fungous elements, a point of importance in the differential diagnosis between *onychomycosis trichophytina* and *O. favosa*, and in favour of the latter. (For further pathological details see Unna and Heller) (53).

2. *Animal.*—The only condition which need detain us under this head is the *itch* (*scabies*), and, indeed, that severe form of it known as the *Norwegian itch.* (See also article "Scabies"). The nail-changes in this rare condition are due to its chronicity, and results from the pustular lesions occurring about the nails, leading to an accumulation of crusts under the the free edge, etc. (54)

XI. Ingrowing Toe-nail (*Unguis incarnatus — Onyxis latérale*).—This affection might perhaps be more correctly called an overgrowth of the soft parts surrounding the nail. It is a well-known condition, occurring with various degrees of severity, and usually attributed to the pressure of badly fitting foot-gear. If this were the sole cause, however, it ought to be much more common, seeing how fashionable are the pointed-toe boots and shoes. Dionis (55) has observed the condition in bare-footed friars, so that other factors play a part. One factor is certainly cutting off the angles of the nail too square, the sharp end left leading to irritation and, no doubt, to secondary microbial infection also.

The disease is practically limited to the big toes, usually the outer side. It is a very painful and troublesome affection, the ulcer which forms secreting a fetid sanious discharge, followed by exuberant granulations.

XII. Anomalous and Obscure Affections of the Nails.—Now and then morbid changes in the nails are met with, which are not connected with either a general or a skin disease. At any rate the nails are, as far as can be made out, the only parts affected, and as no cause can be discovered, the conditions are referred to as *idiopathic,* which does not help us very much. I have thought it well to place such affections in a group by themselves.

A case of this kind came under my own care, and as the details may be of interest, I will here record them (56). The patient was sent to me by Dr. Percy Edmunds of London. She was a young German woman, aged thirty-one. Three months before I saw her the nails of the right-hand began to get pink half-way up, and gradually became longitudinally striated. The left finger-nails then went through the same process, until all the finger-nails became longitudinally ridged, brittle, and uneven (wavy) on the surface. The two big toe-nails were also affected (six weeks). In them the lunula areas were flaky, rough, and discoloured, the nails beyond being normal. Both little toe-nails were absent, they had never been of much account; and some of the other toe-nails were more ridged longitudinally than usual. Associated with the nail-changes, I noticed some *canities:* many white hairs mixed with the black ones on the right eyebrow; the eyelashes on the outer side of the right upper eyelid were white; there were also three tufts of white hairs on the right side of the scalp, viz. near the forehead, just in front of the right ear, and near the neck behind the ear. There was nothing definite in the general health or history to account for the nail-changes. The marked symmetry and the short duration in such a case might be taken as indicating some central nerve origin, a so-called *trophoneurosis*, but this is quite hypothetical (? spinal metamerism) (56A).

Other cases of symmetrical affections of the nails are on record, in which other changes about the extremities were also present (numbness of finger tips, thickening of terminal phalangeal joints, etc.) (57), but in which no cause could be made out, and the nervous origin assumed as the only explanation.

Dystrophy and increased curvature of the finger-nails, without clubbing, I have seen associated with premature baldness and grayness, but without any tangible cause to account for the nutritional changes.

Another type is the loosening of the finger-nails from their bed (*décollement neuropathique des ongles*) (58). The detachment commences at the free edge and may travel down as far as the lunula. The nails themselves are moderately thickened, yellowish, and dirty looking from the accumulation of dirt beneath them. All the finger-nails may be affected, but similar changes have also been observed in the toe-nails. Both sexes suffer. The separation takes place rapidly; all the nails being affected in the course of a few months. It may go on for long periods, varying in intensity. Here, again, a nerve origin has been invoked. Acland records a case of this kind (59). The detachment may be partial and affect certain fingers only of both hands symmetrically (82).

Sub-ungual hæmorrhages may occur apparently spontaneously. The hæmorrhages take place quite apart from scurvy, tabes, injuries, or any other discoverable cause. Heller (60) gives the details and drawing of such a case. Seven of the finger-nails were affected.

Hæmorrhages into the nail substance itself have also been seen. In the case of a female patient of feeble intellect, the subject of hemiplegia, hæmorrhages occurred at the root of all the nails into the nail. The ecchymotic patches eventually grew out with the nails, and the latter grew quite well again. In this instance the hæmorrhages coincided with an attack of hemiplegia (61).

XIII. Malignant Disease of the Nail.—This is very rarely met with. Jonathan Hutchinson, junior, has recorded a case of *epithelioma* of the nail (62). The patient was a man of seventy, and the disease had existed for several months, but for nearly twenty years there had been occasional inflammation with formation of pus under the nail. Part of the nail was apparently healthy, but it was found to be really undermined by the cancerous growth, which also involved the subjacent bone.

XIV. SUB-UNGUAL EXOSTOSIS.—This may lead to changes in the toe-nail, but as the condition is a little beyond the scope of this article, it will not be insisted on in this place.

XV. INTOXICATIONS.—*Arsenic.*—This drug is eliminated through the hair and nails, and in poisoning by it the latter may be variously affected and even shed. Bruce Clarke observed suppuration occur about all the finger- and toe-nails, leading to their detachment from their bed, in a case of arsenical poisoning (63).

In a case of generalised arsenical pigmentation, Mansurow (64) noted that the nails had a brownish tint, which appeared to be due to the lemon-yellow hue of the borders of the nail-cells.

I have seen exaggerated longitudinal ribbing in most of the finger-nails in arsenical keratosis.

In the recent Manchester epidemic of arsenical beer poisoning, the great majority of the patients presented no visible alteration of the nails. Abnormally rapid growth occurred in some cases; when this took place spasmodically wavy transverse ridges were formed. In others, longitudinal striæ and sub-ungual hyperkeratosis occurred (65).

Argyria.—In this condition the nail-bed may be affected, but the nail itself is never involved (66).

Pellagra, which is due to toxic bodies formed in damaged maize, the nails are sometimes thickened and brittle (67), the skin of the fore-arms and hands also suffering.

Gonorrhœa.—Shedding of the nails has been observed in this disease, associated with cornification of the skin, probably of toxic origin (68).

ETIOLOGY.—This has already been incidentally touched upon in the course of the foregoing descriptive survey, as to need little additional detail. In diseases of the nails, it is often very difficult to trace effects to their cause or causes, for the reasons given; in some the factor at work can only be guessed at.

PATHOLOGY.—I have referred to some of the pathological changes, but for fuller details the works of Heller and Unna may be profitably consulted.

DIAGNOSIS.—This subject also has been dealt with in a general way under the various headings, but in this connection the fact must again be insisted upon that the same nail-changes occur in different diseases, and one and the same disease may lead to a variety of nail-changes. In the diagnosis, therefore, all the facts should be taken together—the duration, the mode of development, the distribution (symmetrical or otherwise), the state of the nails and the number affected—that is to say, the case should be investigated on general principles. The patient should be thoroughly examined—skin, hair, and so forth. The history of previous illnesses, including skin affections, the general condition, including age, occupation, nationality, race, etc. Previous treatment should be inquired for, and it is as well to examine the urine.

In the case of skin eruptions, syphilis, leprosy, and so forth, the diagnosis may be easy; at any rate the inference that the nail condition is connected with morbid processes present in the skin or a constitutional taint, is justifiable. The possibility of accidental association, however, must not be lost sight of.

An examination of the nail-scrapings in old-standing disease of one or more nails should always be made, where the nails are alone affected. The *modus operandi* has been described in section x. A negative result, except after prolonged soaking and repeated examination, would not positively exclude a fungus origin. I have found mycelium in cases where negative results had led to the exclusion of ringworm, but it requires some patience.

In some obscure and anomalous cases a diagnosis cannot be made at all *quâ* cause.

The results of treatment, such as the effects of mercury in suspected congenital syphilis, would be a help in clearing up doubts.

The numerous details which it would be necessary to enter into to thoroughly treat the matter of *differential diagnosis* would occupy too much space to be dealt with in the present article. Suffice it to say that if the descriptive portions, together with the above remarks, are carefully read, errors in diagnosis will be reduced to a minimum.

PROGNOSIS.—This is an important matter, from the patient's point of view. Nail diseases generally are obstinate. In some cases, nothing can be done (*epidermolysis bullosa*, some injuries, etc.). In the most favourable cases prognosis as to time and eventual recovery must be guarded. Perseverance in the treatment is a great factor. As a rule, where recovery is possible, it is very gradual.

TREATMENT.—This may be divided into *general* and *local*. As to the former, the patient must be treated as a whole on general principles—cod-liver oil in scrofula, iron and tonics in anæmia, mercury and iodide of potassium in syphilis, and so on. The beneficial effects of appropriate feeding, sunlight, air, change of scene, exercise, etc., need scarcely be insisted upon in the case of individuals suffering from lowered nutrition, depression, and so forth.

The nails and extremities may require protection from cold and heat, or the patient may have to give up an unfavourable occupation, for a time at least, as in irritant dermatitis.

The matter of foot-gear must not be overlooked: ill-fitting boots and shoes must be put aside, and replaced by articles made on common-sense principles. Sandals, with uncovered feet, would in some cases be useful where circumstances permit.

In *congenital* and *hereditary* affections, treatment is reduced practically to protection of the nails and fingers from injuries (including irritating fluids, etc.).

Cuts, Crushes, Splinters, Hæmorrhages.—Whitlows must be treated on the usual surgical principles. When pus forms under the nail the tension must be relieved by cutting or scraping away the nail substance and liberating the pus, followed by the application of iodoform (or of one of its odourless substitutes, europhen, loretin, etc.).

As to *general diseases*, they have already been referred to.

In diseases of the skin, treatment of the general condition is essential. This cannot be gone into here, but the reader will find all details under the diseases themselves in this *Encyclopædia*. My remarks must be limited to the local measures to be adopted for the nails.

In *onychogryposis* the nail must be softened in hot water, to which soda, potash, or soap can be added, and its superfluous portions removed. For this purpose a saw or bone forceps will be found useful. What remains can then be filed down smooth. When the nail is very loose, it can be removed bodily, and the nail-bed protected by means of an ointment, such as ung. zinci. oxidi, spread on linen.

For *leuconychia* of the nails an oxide of tin polishing powder, coloured with one per cent of carmine, can be used, or the nails stained with an alcoholic solution of eosin or carmine to mask the unnatural whiteness.

Other deformities, such as marked reeding, transverse ridges, protuberances, discolorations, are often permanent; but some improvement can be obtained by rubbing down and polishing as recommended above.

In *hyperkeratosis* of the nail-bed, or separation of the nail, as in psoriasis, a salicylic acid ointment, gr. xv.–ʒj. to the ℥j. of lard (or to ʒvj. of lanoline and ʒij. of olive oil (69), or to ℥j. of oleate of zinc ointment) pushed under the nail with a bevelled bit of wood, is useful.

Where there is *hyperidrosis* of the hands and feet, it should be treated. Sulph. præcip. ʒj., ex lacte nocte maneque, is useful, to which pulv. cinnamomi co. ʒij., and pulv. cretæ co. ʒvj. ad ℥j., can be added if there is purging (70).

As for tonic treatment, *arsenic* is the only one exerting a specific action on the nails. It has long been known that it is eliminated through the hair and nails; in chronic poisoning it can be detected in the nail parings. Arsenic acts apparently by stimulating nutrition. It is useful in *psoriasis*, and when the nails alone are affected, and psoriasis suspected, it should be tried with the usual precautions, either alone or combined with iron (ferri et ammon. cit.) Its effects should be watched, as taken over long periods in a routine way it may lead to pigmentation, keratosis, and even cancer of the skin.

In *diseases of the nervous system*, when the damage to the nerve elements is irreparable, little or nothing can be done, except to protect the nails. Improvement of the circulation in the extremities by careful rubbing might be of service.

When in the case of a divided nerve the ends can be brought together, with regeneration, the nails would probably improve with the other tissues.

In *mental strain*, *shocks*, and so forth, quiet, tonics, sea and mountain air, and so forth are indicated.

Simple forms of *inflammation* should be treated by hot fomentations, and removal of any part of the nail, which becomes loose; and iodoform, or its substitutes (europhen, loretin), applied. A lotion of liq. plumbi subacetatis ℥ss., sp. vini rect. ℥j. aq. ad Oj. applied on lint under oiled skin is sometimes very efficacious (71).

In *onychia maligna* the general supporting treatment of the patient is important. Locally the nail, if much affected, should be removed under an *anæsthetic*, and exuberant granulations scraped or cut away, followed by dusting on iodoform (europhen, etc.) and dressing with wet boracic-acid lint, or packing the parts with iodoform gauze (72).

In *syphilitic onychia*, and *perionychia*, the treatment varies with the condition. When dry (*onychia sicca*), mercury should be ordered by the mouth in the usual way. When inflamed or ulcerated, local soothing applications should also be used in addition to the constitutional treatment. Mercury sometimes aggravates ulcerative and suppurative conditions, just as it does pustular, ulcerating, rupial syphilides. Jarisch rightly insists on care in this particular (73). Instead of mercury, tonics, such as perchloride of iron, bark, etc., combined with sea-air and generous diet, should be the line of treatment. As to stimulants, I cannot say I have ever seen any benefit from them in syphilis; the *post hoc propter hoc* fallacy may account for the glowing accounts of the benefits of port wine, etc.

In those cases of *tertiary syphilide* of the palm (improperly still called palmar psoriasis by some) or sole where the nails are involved by continuity, iodide of potassium is indicated, together with a mild ung. hydrargyri (ʒij. to ʒiv. or more ad ℥j.) rubbed into the affected skin area.

In *congenital syphilitic onychia* of infants and children I have in several cases observed the immediate good effects of specific treatment (hyd. c.

cretâ, gr. j. bis vel ter in die), without local applications, but a weak boracic acid or oleate of zinc ointment can be ordered at the same time.

As to the *parasitic diseases*, ringworm and favus need alone detain us. The condition being an obstinate one, a number of remedies have been recommended. The following will be found useful:—Scraping the nail thoroughly with the sharp edge of a slide, followed by soaking it with sulphurous acid or hyposulphite of soda, ʒij. to the ounce of water, applied on lint under oiled silk. Radcliffe-Crocker has found the treatment advocated by Harrison of Bristol for Tinea tonsurans answer well in Tinea unguium. The nail is first scraped, and the following solution, liq. potassæ, aq. dest. āā ℥ss., pot. iodidi ʒss. applied on lint under oiled silk for a quarter of an hour. A second solution, hyd. perchlor. gr. iv., sp. vini rect., aq. dest. āā ℥ss., is then immediately applied in the same manner for twenty-four hours, when the nail is again scraped and the process repeated. (For the scalp the treatment requires much care and medical supervision) (74).

Sabouraud recommends the following solution, applied on absorbent wool: potassium iodide 2 grams, metallic iodine 1 gram, water 1 litre. The wool is covered in by means of a rubber finger-stall. Dubreuilh has not found it succeed in his practice (75).

According to Ehlers, the *kartnögl* of Iceland can be cured by the daily use of a one per cent solution of perchloride of mercury in alcohol applied with a brush (76).

In some cases avulsion of the affected nails has been resorted to with complete success in some cases, but in others the disease has recurred.

Ingrowing Toe-nail.—Various measures have been advocated for this condition. The unhealthy granulations should be destroyed by scraping, or with acid nitrate of mercury, applied with a match end (latter is painful), the sharp angle of the nail removed, and the parts packed with wet boracic acid lint under oiled silk, pressure being applied over the nail.

Avulsion of the nail is recommended as the only procedure of permanent benefit (77), but Scott-Battam has found the following useful: rubbing the granulations with silver nitrate (under cocaine), and pressing small pieces of fine Turkey sponge between the nail and the granulations, a small piece being introduced under the free edge of the nail. The whole is fixed by means of a long narrow strip of plaster, and a soft, easy shoe worn. This is repeated later, and the crust formed by the nitrate of silver removed. On the fourth or fifth day a small piece of sponge must be inserted beneath the edge of the nail, or a portion of it removed with scissors. A mixture of iodoform and alum is then dusted on, and a sponge compress applied. The process may be repeated in a week or ten days if the ulcer has not healed. The dressing should be worn for two or three weeks longer (78),

Anomalous and obscure diseases of the symmetrical type should be treated locally with salicylic acid ointment (*vide supra*), or oleate of tin, gr. xx.–ʒj. to the ounce of lard as recommended by Shoemaker. Liquor arsenicalis should be ordered by the mouth with the precautions already insisted on. At the same time, the patient's surroundings, food, etc., should be attended to, and any derangement corrected (constipation and so forth).

Where *sub-ungual hæmorrhages* occur without apparent cause, inquiry should be made as to *hæmophilia*. The general condition of the patient may call for iron.

In nail-changes caused by *intoxications* the use of the drug or agent must be suspended, and treatment carried out on the lines above suggested.

Epithelioma of the nail necessitates amputation, and the infected glands, if any, should be excised.

Medical Jurisprudence (79).—Deformities, trade discolorations, and diseases of the nails may be a means of identification in the living and the dead. In suspected arsenical poisoning the nails should be chemically examined, as the drug is eliminated through them.

Malingering.—The possibility of simulation must never be overlooked in unusual cases, which do not fit in to any of the foregoing groups. Here the unilaterality corresponding to right- or left-handedness, the bearing of the patient, and the circumstances and surroundings, would make one suspicious. It must be remembered, however, that suspicions should not be communicated to either patients or friends. Nothing should be said unless proof positive be forthcoming. Even then the medical man gets more abuse than thanks. Personally I have never seen a case of nail malingering.

Conclusion.—In the foregoing an attempt has been made to give as full and practical an account of diseases of the nails as possible, but many interesting details and minute points have necessarily had to be omitted. The reader desirous of going more deeply into the subject will find much to interest him in various publications and collections, a list of which is appended at the end of the accompanying bibliography (80).

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Narcotics.

See Toxicology, Morphinomania.

Neck, Region of.

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Anatomical Points.—For precision in anatomical description the region of the neck has been divided into triangles. Thus the space bounded by the middle line of the neck in front, by the sterno-mastoid behind, and above by the lower border of the jaw, and an imaginary line connecting it with the mastoid, is termed the anterior triangle. This is further divided by the anterior belly of the omo-hyoid muscle and by the two bellies of the digastric into the inferior carotid, superior carotid, and digastric triangles in order from below upwards. In the same way the triangular space between the sterno-mastoid muscle in front and the trapezius behind, of which the base is formed by the middle third of the clavicle, is named the posterior triangle. It, in turn, is divided into two smaller triangles by the posterior belly of the omo-hyoid, the upper the occipital, and the lower the subclavian. The extent of these spaces varies much with the muscularity of the individual.

The Deep Fasciæ.—The arrangement of the deep fascia has an important bearing on the direction taken by fluid collections in the neck. It is also not without an influence on the direction of growth of solid tumours. Although other smaller septa are given off, chiefly in the posterior part of the neck, three main layers of deep fascia exist: (1) An outer layer which forms a continuous collar round the entire neck. This is attached posteriorly to the ligamentum nuchæ, and, as it sweeps round the neck, it splits twice, to enclose first the trapezius, and then the sterno-mastoid. Over these muscles it is less strongly marked than elsewhere. Above it is attached to the lower jaw, the mastoid process, and the occiput, below to the sternum, clavicle, and the spine of the scapula. As it passes over the hyoid it is attached to that bone also. (2) A middle layer (the pretracheal fascia), the least well marked of the three. This springs from the outer layer beneath the sterno-mastoid, helps to form the carotid sheath, and then passes forward in front of the thyroid gland and trachea, to both of which it gives a fibrous investment. It also furnishes sheaths for the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles. It is attached above to the hyoid bone and below to the sternum, but is prolonged down to blend with the pericardium. On each side it is attached to the clavicle, and it finally becomes continuous with the sheath of the axillary vessels. (3) An inner layer (the prevertebral fascia), which lies immediately in front of the prevertebral muscles. It, like the middle layer, is derived from the outer layer, and takes part in the formation of the carotid sheath. Above it is fixed to the base of the skull, while below it is carried down over the longus colli muscles into the thorax. It is attached at the sides to the transverse process of the vertebræ. From the above description it will be seen that a knife introduced from before backwards would traverse three separate planes of deep fascia before reaching the spinal column. Further, by the above arrangement three fascial compartments are found. In the most anterior of these the descent of fluid is obviously limited by the sternum. In the middle and posterior spaces, however, pus may easily extend into the thorax. Pus, moreover, occasionally follows the extension of the middle layer into the axilla. Superficial to the deep fascia the platysma and the external jugular vein are the only structures of importance.

The Vessels and Nerves.—In the removal of tumours these are often in danger, and in extensive operations some may have to be divided. Here only brief notes on the position of the more important can be given. The direction of the common and external carotids is the same, namely, that of a line drawn from the sterno-clavicular joint to a point half-way between the angle of the jaw and the mastoid process. The external carotid portion of this line begins at the level of the upper border of the thyroid cartilage, the point at which the common carotid ends. The internal carotid may be indicated by a similar line, but it lies at a deeper level, and is also a little external to the external carotid. The internal jugular vein and the vagus nerve are included in the same sheath as the common carotid. The internal jugular vein lies to the outer side; it is large, is very thin, and in most cases overlaps the artery to a certain extent, particularly on the left side. If the tissues happen to be on the stretch it may look more like a band of fascia than a vein. Should the breathing become at all forcible during an operation, it may be seen to swell out during expiration and collapse during inspiration. Owing to the adhesion of the fascia to the deep veins of the neck, the danger of air entering them during the removal of tumours, etc. must not be forgotten. To avoid this in operations all doubtful bands should be clamped before division, and when divided should be cut completely across.

The vagus nerve lies behind and between the vessels. The formation of the carotid sheath has been referred to above; in front of it lies the small descendens noni nerve, and behind it the cord of the sympathetic. The lateral mobility of the sheath and the structures it contains is considerable, and the surgeon must therefore not be surprised to occasionally find its position in the neck considerably altered by tumour growth. The line of the subclavian artery in the neck may be roughly indicated by a curved line extending from the sterno-clavicular joint to a point nearly opposite the centre of the clavicle. The summit of this curve is usually about half an inch above the clavicle, but it varies considerably. The vein is at a lower level than the artery, and is also anterior to it. In operations on the third part of the artery it is in much less danger than the lowest of the nerve cords which pass down above the artery on their way to the axilla to form the brachial plexus. The external jugular vein, after it has pierced the deep fascia, crosses this part of the artery with several of its tributaries on its way to the subclavian vein. The scalenus anticus lies over the second part. From the first part of the artery come off the thoracic axis, the vertebral and internal mammary arteries; it is crossed by the internal jugular vein and the vagus and phrenic nerves. Behind and below the pleura and the recurrent laryngeal nerve (on the right side) are in close connection. It is therefore evident that operations in this neighbourhood can only be carried out with great care. The greater cornu of the hyoid bone is a useful guide to the position of the anterior branches of the external carotid, the lingual being given off opposite to it, the superior thyroid below it, and the facial a short distance above it. It should be remembered that the veins corresponding to these vessels must cross the carotid in order to reach the internal jugular vein. The occipital artery generally arises at the same level as the facial. The hypoglossal nerve winds round it close to its origin on its way to the floor of the mouth. Lower down the superior laryngeal branch of the vagus must be avoided on its way to pierce the thyro-hyoid membrane (internal branch) to supply the mucous membrane of the larynx. The spinal accessory nerve is in considerable danger in extensive removal of glands. It enters the sterno-mastoid about two inches below the tip of the mastoid, and emerges from it about the centre of its posterior border.

Lymphatics.—These have already been dealt with in the description given of the lymphatics of the whole body (vol. vii. p. 189). The frequency of glandular enlargements in the neck, however, makes it necessary to refer to the matter again.

A superficial chain of glands follows the course of the external jugular vein. The lymph it receives comes from the outer ear, the skin of the front and back of the neck, the occipital and mastoid glands, and (partly) from the parotid and submaxillary glands. A deep cervical chain of glands follows and often adheres to the internal jugular vein. The upper set, extending from the bifurcation of the carotid to the base of the skull, are called the deep superior cervical, the lower the deep inferior cervical. In addition, a set of glands upon the submaxillary salivary gland, and a set in the supraclavicular region, are known respectively by these names. The deep superior cervical are fed from the cranial cavity, the posterior part of the tongue, the lower pharynx, the larynx, the thyroid gland, the deep muscles of the neck, and partly from the submaxillary glands. The deep inferior cervical ultimately gets the lymph from all the other glands of the neck. The area drained by the submaxillary set is large, consisting of the face, lips, floor of the mouth, gums, and teeth of lower jaw, anterior part of the tongue, and the parotid lymphatic glands. The supraclavicular are a continuation of the deep inferior cervical. They communicate with the lymphatics of the breast, axilla, and mediastinum. To the occipital glands, placed on the origin of the trapezius, run the lymphatic vessels of the back of the head.

The Middle Line of the Neck.—The anatomy of this region is important, both on account of the variety of operations which are performed there, and also from the greater importance of wounds in this region as compared with other wounds of the neck. Beginning at the symphysis menti the following are the structures met with from above downwards in order: (1) The mylo-hyoid raphe. Just under the chin, however, the anterior bellies of the digastric muscles meet, and the platysma muscles decussate across the middle line. (2) The hyoid bone; (3) The thyro-hyoid membrane; (4) The pomum Adami and thyroid cartilage; (5) The crico-thyroid membrane; (6) The cricoid cartilage (opposite the sixth cervical vertebra); (7) The upper rings of the trachea; (8) The isthmus of the thyroid gland; (9) The trachea with the inferior thyroid plexus of veins. The presence of these veins and the greater depth of the trachea make the "low operation" of tracheotomy (below the isthmus) more difficult than the "high operation" (above the isthmus). The occasional presence of the thyroidea ima artery and, in children under two years, the thymus gland are further mesial structures which may be met with. It must not be forgotten, too, that the structures normally forming the middle line of the neck may be displaced to one side by an inflammatory swelling or by a tumour. The surgeon, therefore, should always be most careful to identify the landmarks of the neck before operating, particularly in obese subjects.

INJURIES.—*Burns.*—The neck has long been recognised as a most serious site for burns, chiefly on account of the terrible deformity which may follow cicatrisation; owing to the laxity of the tissues the chin may be drawn down in extreme cases so as to touch the shoulder, or the mouth may similarly be pulled into the region of the neck. In the treatment of deep burns, therefore, this tendency to contraction should be met by the liberal application of skin drafts, using Thiersch's method, the neck at the same time being kept extended by some form of splint.

Contusions, etc.—Contusions or fractures of the larynx or fractures of the hyoid bone occasionally occur as the result of kicks or manual compression, as in garrotting. Contusions elsewhere are usually not followed by serious results.

Wounds.—Wounds of the sides and nape of the neck call for no special reference, hæmorrhage being treated in the same way as elsewhere. Wounds, however, of the anterior aspect acquire a special importance owing to the frequent involvement of the food and air passages.

Cut Throat.—The wound producing this injury is generally incised, is more or less transverse, and, though it may be met with at any level in the middle line, it perhaps most often involves the thyro-hyoid membrane. Here the pharynx is opened into. The wound is almost invariably homicidal or suicidal. If the latter, it is (if the operator is right-handed) directed obliquely from left to right, and is deepest at the commencement. The wound may be quite shallow or so deep as to reach the spine. The great vessels of the neck usually escape. This is explained by the depth at which they lie, and by the protection afforded to them by the larynx and sterno-mastoid muscles. The signs depend on the depth and site of the wound. In certain situations, as over the larynx, the bleeding may be insignificant. On the other hand, when the cut is above the hyoid bone, the lingual or facial arteries may be severed and, when below the cricoid cartilage, the inferior thyroid arteries and thyroid veins. If the great vessels are involved the patient generally dies within a few seconds. As regards damage to other structures, when the wound is above the hyoid bone the tongue and hypoglossal nerve may be divided, when it involves the thyro-hyoid membrane the superior laryngeal nerve and the epiglottis may be cut.

Food or saliva escaping from the wound indicates that the pharynx or œsophagus have been injured. When the air passages have been opened into more or less loss of voice occurs. This is complete if the vocal cords are involved. In many cases much embarrassment of breathing is present. This may be caused by the tongue falling back, by partial separation of the upper and lower portions of the windpipe, by displacement of the cut epiglottis, or by blood getting into the air passages. Besides the immediate dangers due to shock, bleeding, and asphyxia, secondary complications exist. Such are œdema, glottidis, bronchitis, and broncho-pneumonia, cellulitis extending into the mediastinum, and surgical emphysema. Œdema glottidis is naturally more liable to occur when the wound is above the cords.

If hæmorrhage or alarming dyspnœa is present these conditions must be first attended to. If severe hæmorrhage has taken place transfusion of saline fluid is indicated in all cases. As regards the wound much depends on the case. The surgeon will be influenced by its site, its character, and, above all, by whether he thinks it will become septic or not. If possible it should be closed—the wounded trachea, cartilages, etc. being sutured at the same time. Drainage is generally required. In very many cases it is safer, and in some instances absolutely necessary, to insert a tracheotomy tube in the windpipe for several days. In such cases, if the wound is below the thyroid cartilage, it may be made use of. In other cases a high tracheotomy should be performed and the original wound sutured. If the œsophagus is injured it should be sewn up, but a drainage tube should always be left in the wound. In the after treatment of cut throat care must be taken that apposition of the parts be assisted by maintaining the neck as far as possible in the position of flexion. Needless to say no suicidal case should ever be left alone.

INFLAMMATORY AFFECTIONS.—*Cellulitis.*—This is met with in varying degrees, most commonly as the result of a septic wound and after scarlet fever or diphtheria. The symptoms and treatment are the same as those of cellulitis in other parts.

Angina Ludovici.—This is a peculiar and very severe form of cellulitis, beginning generally below the jaw in the submaxillary region, and extending rapidly downwards and to the middle line of the neck. By some it has been termed *submaxillary cellulitis.* It occurs underneath the deep fascia and is attended by marked constitutional disturbance. Great swelling is nearly always present, and the tongue is very often pushed upwards and backwards so as to cause difficulty in swallowing and in breathing. This is one of the most characteristic features of the disease. Much brawny induration exists, the skin becomes œdematous and discoloured, and considerable sloughing usually takes place. The cellular tissue soon becomes infiltrated with extremely foul pus which may burrow widely. The patient frequently succumbs within a few days from septic intoxication or from œdema of the glottis. The source of infection is somewhat obscure, but in many cases it is most probably of buccal origin. The treatment consists in early and free incisions, usually in the middle line of the neck, followed by warm fomentations. Tracheotomy in many cases may be required. *Boils* occur in the neck as elsewhere, and a very favourite seat for *carbuncle* is the nape of the neck.

ABSCESS.—Both *acute* and *chronic abscess* occur. The former is usually the result of acute inflammation of lymphatic glands that have absorbed septic material from the mouth, throat, or elsewhere. Acute inflammation of the lower jaw is also responsible for a certain number of cases. As has been pointed out in describing the fascia, pus in the deeper parts of the neck may extend into the mediastinum or into the axilla. For this reason both in acute and chronic abscesses pus should be evacuated as soon as possible. Chronic abscesses are usually the result of the breaking down of tubercular glands or of tubercular disease of the cervical vertebræ (*chronic retro-pharyngeal abscess*). Retro-pharyngeal abscesses are deeply seated in the neck, although as a rule easily palpable from the mouth. They are best opened through the neck by Hilton's method, as first pointed out by Chiene. By so doing the risk of sepsis is considerably diminished. The opening is made just posterior to the sterno-mastoid. An *empyema* may rarely point in the neck.

BURSÆ are occasionally met with. They occur only in the front of the neck and in two situations, viz. in front of the larynx or above it between the back of the hyoid bone and the thyroid cartilage. They are generally, but not always, of small size, move with the larynx in swallowing, and are lined with endothelium. Incision and drainage is usually sufficient to cure them. If this fails they should be excised.

CYSTS AND CYSTIC TUMOURS.—The neck is a favourite site for these swellings, which may be either congenital or acquired. The congenital will be referred to first.

Hygroma or Multilocular Cystic Tumour of the Neck.—This is often of large size, and consists of a series of lymphatic spaces embedded in connective tissue. These spaces are lined by endothelium, and contain a thin serous fluid and some cholesterin crystals. The outline of the tumour, which is soft and elastic to the touch, is most irregular. It possesses no capsule, and as it enlarges it usually sends processes deeply into the neck, which have been known to follow the deep fascia into the thorax or axilla. Besides causing great deformity the tumour may seriously press on the trachea and other structures. Complete excision should be performed if possible, failing that a partial excision has occasionally been successful in bringing about an arrest of growth.

Dermoid cysts, lined by squamous epithelium, and containing sebaceous material and sometimes hair, are found in two places. The most common site is under the chin in the middle line between the genio-hyoglossus and mylo-hyoid muscles. Their removal, unless they are very small, is best done through a median incision in the neck, and not through the mouth. Less frequently dermoids are found at the side of the neck at a position corresponding to one of the branchial clefts of the embryo. They are here more or less adherent to the great vessels. This must be borne in mind in excising them.

Branchial cysts and *thyro-glossal cysts* are two other rare cysts which require mention. Branchial cysts result from incomplete closure of the branchial clefts, most commonly of the third (near the hyoid bone). They are lined generally with squamous epithelium, and contain either a glairy or sebaceous fluid. Thyro-glossal cysts occur in the middle line and develop in connection with the remnants of the thyro-glossal duct or track of His. This tract extends from the foramen cæcum in the tongue to the isthmus of the thyroid, descending behind the hyoid bone and in front of the larynx. The cyst in question represents the lower portion, and is to be found, therefore, between the hyoid bone and the thyroid gland. It resembles the latter organ both in structure and contents, and it moves with deglutition. In these and in branchial cysts the treatment is the same, namely, excision.

Of *acquired* cysts perhaps the most important is the *unilocular serous cyst* or *hydrocele of the neck.* This is a large, smooth, thin-walled, tense, and sometimes translucent cyst. A point of diagnostic importance is that it is almost invariably posterior to the sterno-mastoid. Its exact origin has not been definitely settled. It should be dissected out.

Blood cysts occasionally occur, and are due either to the dilatation of a vein or to extravasation of blood into a pre-existing cyst.

In *aneurysms,* in addition to the ordinary signs (see vol. i. pp. 219 and 240), the special symptoms which may arise from pressure upon structures in the neck may be looked for. Thus, in carotid aneurysm, stridor from pressure on the trachea or recurrent laryngeal nerve, dysphagia from pressure on the œsophagus, dilatation or contraction of one pupil from stimulation or over-stimulation respectively of the sympathetic nerve, may occur. In subclavian aneurysm symptoms indicative of pressure on the brachial plexus or phrenic nerve may be present. *Sebaceous cysts* of the skin are common and resemble those found in other parts. *Hydatid cysts* in the neck are extremely rare. *Aeroceles,* or pouch-like protrusions from the trachea or larynx, *pharyngoceles,* or similar diverticula from the pharynx, occur, but are rare. The same may be said of *pneumatocele,* in which the apex of the lung protrudes through the pleura and forms a tumour in the posterior triangle of the neck. The term *malignant cyst of the neck* is applied to a form of carcinoma, which seems occasionally to arise primarily in the epithelium in the remains of the branchial clefts.

Solid Tumours of the Neck.—It may be said at once that enlargements of the lymphatic glands form by far the commonest class of solid tumours met with in the neck. The subject has already been dealt with in "Diseases of the Lymphatic Glands" (vol. vii. pp. 193-204). The following are the main points referring to glands in this region. *Acute lymphadenitis* from absorption of irritating material occurs here as elsewhere. The source may be a septic cut or the inflamed pharynx of scarlatina, etc.

Chronic lymphadenitis is the result either of long-continued peripheral irritation, or of the presence of the tubercle bacillus, or of the "poison" of syphilis.

In enlargement, due to peripheral irritation, the cause should be sought for and removed. The list is a long one—diseased conditions of the tonsils, the pharynx, the teeth, the nose, the ear, the scalp, the naso-pharynx, are all at times responsible for glandular inflammation.

In *tubercular lymphadenitis* the glands enlarge slowly, are at first discrete and movable, but later become matted together and adherent to the surrounding parts from periadenitis. They also tend to caseate, break down, and form tubercular abscesses in a characteristic manner. In many cases the patient possesses the physiognomy which is suggestive, though not diagnostic of tuberculosis. The treatment short of operation has already been described elsewhere. The surgeon operating on a case of tubercular glands must always be prepared for an extensive operation. As often as not the removal of one gland reveals the presence of another, and when this is taken away still another, and so on. If operation is to be done it should be radical: *all* the glands should be taken away. The deep glands are found lying along the internal jugular vein. When they are very adherent the safest plan is to remove a portion of the vein along with them. Further, in order to get free access it is often advisable to divide the sterno-mastoid and unite it again when the glands have been removed. The incisions in these operations should where possible follow the normal creases in the skin. In this way the scar is made less conspicuous. Broken-down glands must be removed with the sharp spoon. The cavity is then touched with pure phenol and stuffed with iodoform gauze. The purplish, sodden, undermined skin round the edges should also be excised.

Syphilitic enlargement frequently occurs during the secondary stage of the disease. The glands are hard, not of large size, not tender, and freely movable. The occipital ones are very commonly affected. The history and other evidences of the disease will help in the diagnosis.

In *lymphadenoma,* which is usually met with in young males, the cervical glands are almost invariably the first in the body to become affected. The glands are not tender, and are generally fairly soft. They enlarge slowly, show no tendency to caseate, and as a rule are discrete, and freely movable. One or two glands only may be implicated, or a considerable number may enlarge and form a large mass round the neck. As the disease progresses, the glands of the axilla, and later of nearly every other part of the body, enlarge. Sometimes they become adherent to one another, in which case the difficulty of the diagnosis between lymphadenoma and tubercle, often troublesome enough already, is increased. When the glands of the neck occasionally enlarge in the lymphæmic variety of *leucocythæmia,* the presence of an abnormal number of leucocytes in the blood in the latter is the only means of differentiating the two conditions, anæmia being present in both. In the treatment of lymphadenoma, when arsenic has been used without effect, excision of the glands, if there is no evidence of infra-thoracic growth, should be tried.

Lympho-sarcoma, or primary sarcoma of the lymphatic glands, resembles lympho-adenoma very closely, except in the very much greater rapidity of its growth. Its early and complete removal afford the only chance for the patient.

Secondary enlargement following malignant disease is common, and may be found following epithelioma of the lips, tongue, larynx, carcinoma of the mamma, etc., in the related glands. These, when they are definitely infiltrated, are extremely hard, irregular, and generally painful. They quickly become adherent to neighbouring parts and to each other, and grow rapidly. They are also prone to break down in the centre, and so to form spurious cysts. Secondary sarcomatous enlargements also occur, but less frequently, as after sarcoma of the tonsil or of the salivary glands. The question of removal will naturally depend on the amount of the infiltration, and the site, extent, and duration of the primary lesion.

Enlargements of the Thyroid Gland.—These are simple hypertrophy, fibrous or cystic enlargement, pulsating goitre, exophthalmic goitre, and more rarely malignant disease, acute inflammation, and the condition known as acute goitre. (See "Thyroid Gland.")

Lipomata.—These are by no means uncommon. They are found over the nape of the neck and also in the submaxillary region. The neck is also the seat of the large *diffuse* variety of lipoma. The latter form of fatty tumour is best left alone. *Nævi* also occur. *Fibromata, chondromata, osteomata* are all extremely rare.

Sterno-mastoid tumour (*sterno-mastoid hæmatoma*).—This is a localised induration of the sterno-mastoid not infrequently noticed shortly after birth. It is most probably the result of a partial rupture of the muscle during delivery, and not a manifestation of congenital syphilis as has been thought by some. The condition may be followed by torticollis. Ordinary gummata also are sometimes met with in the sterno-mastoid.

DIAGNOSIS.—The main diagnostic points regarding tumours of the neck have already, in most cases, been touched on. It should be remembered that the principal sign of a thyroid tumour, solid or cystic, is that it moves with deglutition. This sign, however, may occasionally be absent in thyroid tumours of great size, and, as has been pointed out above, it may be present in certain other rare swellings. In pulsating swellings of the neck, solid or fluid, the surgeon must be careful to satisfy himself (see "Aneurysm") that the pulsation felt is not the communicated pulsation of an adjacent artery. Again, in tumours *under* the sterno-mastoid the muscle can generally be displaced to one side; in tumours *of* the sterno-mastoid they move with the muscle. In many cases the diagnosis of swellings in the neck has to be made by the process of exclusion, and after the removal of all sources of peripheral irritation. In some cases an absolute diagnosis previous to operation cannot be made at all. The greatest difficulties in this respect are presented by the *glandular* swellings of the neck.

Negro Lethargy. *See* SLEEPING SICKNESS.

Nephritis.

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See also KIDNEY, URÆMIA.

NEPHRITIS includes several forms of acute and chronic structural disease of the kidney, commonly associated with albuminuria and dropsy, with uræmic symptoms, and other results of the interference with the normal work of the kidney. Albuminuria may occur in other conditions, as in congestion, the result of heart or lung disease, or in obstruction due to emboli; it is also common in numerous febrile conditions, while perhaps it is most frequent in the various functional forms of albuminuria to which the names physiological, dietetic, cyclical, etc. have been applied. In these functional forms albuminuria may be a prelude to chronic kidney disease, but, as a rule, no serious trouble ensues. In these conditions there is seldom any interference with eliminative work; more definite structural changes, which produce such interference, are included under the comprehensive term of nephritis.

To express imperfect elimination the term "renal inadequacy" has been employed. It is somewhat unfortunate that this term has been used in two different senses. Sir Andrew Clark (*Brit. Med. Journ.* 1884) described a class of cases in which, although the kidney presented no alteration of structure, it was unable to produce a perfectly healthy urine. In these the urine is low in density and deficient in solids; he considered that with this renal inadequacy there is a curious inability to repair damage by accident or disease, and that there is great uncertainty as to the result of the performance of an ordinary surgical operation. This form of inadequacy is often regarded as an early pre-albuminuric stage of renal cirrhosis. In another variety the same term has been used to denote an imperfect elimination of fluid, with resulting concentration; in these, cardiac hypertrophy is absent, but there is marked myocardial weakness and disturbance of the digestive system, symptoms which correspond with hysterical anuria, though it may perhaps have to be regarded as due to nephritis following lithiasis.

MORBID ANATOMY OF NEPHRITIS

The morbid anatomy of nephritis may be the more conveniently studied if we remember that the different structures of the kidney may frequently be affected independently, and that when different structures are concurrently affected, the extent to which each part is involved is liable to great variations. Thus the tubules and their epithelium, which together constitute the parenchyma of the kidney, sometimes show the most marked alterations, and this is especially seen in most of the acute forms of kidney disease. In chronic conditions the interstitial tissue, which in the healthy kidney is only present in small quantity, may increase considerably as the result of inflammatory processes; and, thirdly, the blood-vessels and the glomeruli appear liable to separate affection, and, indeed, the epithelial cells, which coat the capillaries of the glomerulus, have been described as undergoing an inflammatory process, which, for some authors, constitutes the primary and perhaps the most important change.

Acute Nephritis

Syn.—Acute desquamative nephritis, acute tubal nephritis, acute parenchymatous nephritis, acute Bright's disease.

In acute nephritis the primary changes are undoubtedly connected with the tubules and glomeruli, and these changes are found to be fairly constant when the kidney is examined microscopically, although the size, shape, and general appearance of the kidney are largely dependent upon the stage the disease has reached when death occurs. Sometimes the kidney is very little larger than the normal, the cortex is of a dark colour, and the glomeruli stand out as minute pale spots. Sometimes the kidney is increased considerably in size, it may indeed be swollen to almost twice its normal bulk. It then has a more rounded appearance than usual; the capsule can be separated easily, and the surface is pale. On section, the increase in size is found to be due mainly to an increase in the thickness of the cortex, which is of a greyish-red colour, while the central portions, the pyramids, are of a deeper red, owing to the congestion of their vessels. Frequently, both on the surface and on section, bright red spots are found. Sometimes these are due to minute hæmorrhages, sometimes to engorgement of the glomeruli.

In a third variety of acute nephritis the degree of congestion is very much greater, so that the colour is dark red or brown, and on section the kidneys have been described as "dripping with blood."

On examination microscopically changes are found in the tubes, in the interstitial tissue, and in the glomeruli. The change within the tubes mostly consists in a peculiar opaque appearance of the epithelial cells; these may be swollen or granular, or they may be filled with fat granules, and they frequently tend to separate readily from the wall of the tubule. The lumen is often obliterated by *débris* of altered epithelial cells, leucocytes, and coagulated albuminous fluid; and sometimes the tubules appear to be blocked with a compact mass of blood corpuscles. Hyaline, epithelial, and blood casts are often seen, both in the cortex and in the looped tubules of the pyramids. When the kidneys are large it is frequently found that leucocytes have exuded, and have been accompanied by an inflammatory fluid; these exudations are most marked near the Malpighian capsules. The glomerular changes, upon which some authors lay great stress, have been described as a form of capsulitis. The capsule is distended by a finely granular mass, enclosing numerous small nuclei, and sometimes hæmorrhages occur within the capsule. Klebs, Klein, and Greenfield consider that the nuclei of the capillary tufts in the glomerulus proliferate, and that this proliferation is accompanied by an excessive growth of nuclei within the capsule, which leads to adhesion between it and the glomerulus, and ultimately to compression and atrophy of the latter. These lesions are sometimes limited to a few of the glomeruli, but they have been also described as affecting a very large proportion of them. This condition has been termed glomerular nephritis, and it appears to be most common in the form of acute nephritis consecutive to scarlet fever. In such cases the lesions within the tubules have been considered to be secondary to the abolition of the work of the glomerulus.

The transition from the morbid anatomy of acute nephritis to that of chronic nephritis is extremely ill-defined, and this doubtless is the explanation of the great variation in the appearances which have been described.

Acute Nephritis after Scarlet Fever.—When death occurs in the course of scarlet fever, or during convalescence from this disease, the kidneys are almost invariably found to be greatly altered in appearance. Friedländer describes three distinct changes in the kidney associated with scarlet fever: (1) Initial catarrhal, the usual form; (2) The large, limp, hæmorrhagic kidney, interstitial septic form; and (3) Nephritis post-scarlatinosa, the glomerular form.

Friedländer's initial catarrhal form probably coincides with the appearances of febrile albuminuria or abortive nephritis, and is found when there may have been no special renal symptoms, and when death has resulted from some other complication. The septic form may also have attracted very little attention during life; hæmaturia and much albuminuria are rare with this condition. The third form constitutes scarlatinal nephritis, and for descriptive purposes it will be convenient to separate three broadly differentiated types.

When death has occurred during the first or second week the kidneys are very little altered in size; they are engorged, and the capsule can be readily separated. The surface may show radiating red lines of injection or small extravasations. On section the whole parenchyma may be of a chocolate hue from intense engorgement.

From the second to the sixth week the kidneys are enlarged and firm, and the surface is pale and mottled with yellowish spots. These appearances extend through the cortical layer, but the medullary substance is hyperæmic, from its junction with the cortex almost to the ends of the papillæ. The hyperæmia is often associated with striæ of a deep colour passing along the pyramids.

At a later stage contraction occurs, so that the kidneys may be of normal size, or even somewhat smaller. They may still be pale, but they are more firm, and may even be rather difficult to cut.

The microscopic changes in scarlatinal nephritis mainly affect the glomeruli and the tissues in their neighbourhood. In the early stages the vessels in these parts are found to be crowded with masses of corpuscles, which are most numerous between the vessels of the tuft of capillaries, while they are also frequently found in considerable numbers outside the tuft, but within Bowman's capsule. The vessels of the tuft sometimes rupture, and Bowman's capsule becomes filled with blood corpuscles, which are often seen extending down the tubules; compact masses of corpuscles due to hæmorrhage may also be found in lines between the tubules. The epithelial cells in the convoluted tubes are enlarged and cloudy, and they may almost obliterate the lumen which is further obstructed by granular débris and casts. Similar changes affect the epithelial cells lining Bowman's capsule. At a later stage the round cells in the neighbourhood of the vessels and round the capsules of the glomeruli proliferate, and the epithelial cells lining Bowman's capsule undergo rapid desquamation; hence the space between the tuft and the capsule is filled with collections of exfoliated epithelium. The capillary tufts may be engorged so that they occupy the whole of the space within the capsule, or they may be compressed and relatively empty, owing to the pressure exerted upon them by the desquamated epithelium and the hæmorrhagic effusions.

During contraction in the third stage Bowman's capsule is much thickened, and the whole Malpighian body is larger than usual, owing to the increase of nucleated cells surrounding and compressing the capillary tuft. Similar increase of connective-tissue corpuscles is found round the outside of Bowman's capsule, and between the convoluted tubes, which may be compressed and distorted by the new growth. The epithelial cells of the convoluted tubes are generally flattened at this stage, and the lumen, which may be larger than in the normal condition, is often filled with débris and casts.

In all stages the interlobular arteries are thickened and prominent, the extent of change increasing with the duration of the disease.

Chronic Nephritis

Syn.—Chronic parenchymatous nephritis, chronic tubal nephritis, chronic catarrhal nephritis.

The macroscopic appearances of the kidney in chronic nephritis are subject to great variations. Thus, cases which are practically indistinguishable, so far as symptoms are concerned, may be associated with either large white kidney, or with the smaller granular kidney, or with the speckled kidney. The microscopic examination will, however, generally indicate fundamental points of resemblance. If the disease terminates within a year of the first development of symptoms, the kidney is, as a rule, found to be larger than usual. Sometimes this enlargement is extreme, and the kidneys may be from twice to three times the normal size. The capsule is usually readily detached, and the surface is smooth and somewhat pale; sometimes after removal of the capsule the surface is finely granular, and perhaps somewhat torn. There are usually stellate hæmorrhages or engorgements of the stellate veins. On section, whitish or yellowish streaks and spots may be found in the cortex, as though the kidneys had been strewn with fine sand. The cortex is considerably thickened, and may nearly equal the thickness of the cones. The cones are of a darker red colour, and contrast with the pale cortex.

Microscopic examination shows that the changes are not uniformly distributed, but affect certain areas, while intervening tracts of tissue appear to be normal. All the structures of the kidney may, however, be involved; in the convoluted tubes the epithelium is generally swollen, cloudy, and less transparent than usual; the degree of swelling may be sufficient almost to occlude the tubule, and also to interfere with the freedom of circulation. The combined result of distension of the tubes and of the compression of the blood-vessels, is seen in the white or gray colour of the cortex. Sometimes, however, the tubules are found with the epithelium desquamated or proliferating; or they may be entirely denuded of epithelium. Occasionally the renal epithelium is replaced by thin, flattened cells, the lumen of the tube being much increased in diameter. The extent to which the interstitial tissue is affected will also vary considerably. It is generally considered that there is cellular infiltration between the tubules, which leads to the formation of fibrous connective tissue and subsequent contraction. This development of interstitial tissue may ultimately produce irregularities of the surface and partial adhesion of the capsule.

The changes affecting the Malpighian tufts are similar to those of acute nephritis. As the result of subsequent changes, however, the glomeruli appear more or less atrophied, while the capsule of Bowman is thickened, and its epithelial lining has undergone degeneration. Frequently the Malpighian tuft is infiltrated with leucocytes, and the surrounding tissue also presents an excess of nuclei. Greenfield has described three changes connected with the capsule: (1) Pericapsulitis, or cellular infiltration, and tissue formation occurring chiefly outside; (2) Hyaline thickening of the capsule itself; (3) Endo-capsulitis, or the formation of concentric laminæ of cells and tissue inside the capsule, between it and the glomerular tuft. In chronic cases these concentric laminæ are due to a new formation between the capsule and the tuft, and the capillaries meanwhile undergo hyaline thickening. The capsule, in advanced cases, is striated and concentrically thickened, and blends with the sclerosed glomerular tuft. These changes are not invariably present; they are most common in chronic nephritis originating in scarlatinal nephritis. The branches of small arteries within the kidney are invariably found to be considerably thickened, the hypertrophy affecting the muscular coat. Some thickening, however, of the fibrous wall of the vessel must also be recognised. The vessels may be engorged, and some of the tubes may often be filled with blood, while in other parts they may contain casts. The increase in the size of the kidney is due to inflammatory deposits in the parenchyma and interstitial tissues. If, however, the overgrowth of interstitial elements is associated with marked atrophy of the parenchyma, the kidney may not appear to have undergone much alteration in size.

On the other hand, if the new connective tissue undergoes contraction, the size, weight, and appearance of the kidney will differ greatly from the appearances above described. The kidney, however, remains more pale and mottled than in the normal condition, and, though the surface may become uneven and granular, the colour alone indicates that the case is one of contracted white kidney, instead of being one of small red granular or cirrhosed kidney. When the kidney is thus diminished in size the chief change affects the cortex, which becomes narrower, and on microscopic examination wide tracts of fibrous tissue, almost homogeneous in appearance, may be found lying either immediately below the capsule or in the course of the interlobular arteries. In this tissue, atrophied tubes, Malpighian bodies, and blood-vessels may be found, and small cysts often result from blocking of the tubes.

From the above it will be seen that although the macroscopic appearances of the kidney are so dissimilar, yet the microscopic changes are those which might be anticipated as the result of a chronic process; in fact, the difference in appearance depends largely upon the length of time that has elapsed between the commencement of the disease and its termination. The parenchymatous changes may be more apparent in the earlier stages of the large white kidney, while the interstitial changes predominate in the later conditions, but all the tissues are simultaneously affected, and the size of the kidney seems to depend upon the degree of contraction and atrophy that has succeeded the inflammatory process. The tendency of chronic nephritis is towards atrophy and contraction, and most observers consider that when the kidney is small, pale, with a narrow cortex and granular surface, there has been an earlier stage in which it was enlarged, white, and with a thickened cortex.

Renal Cirrhosis

Syn.—Chronic interstitial nephritis, red granular kidney, chronic gouty nephritis.

In advanced forms of renal cirrhosis the kidneys are very much diminished in size, but both are rarely affected to the same extent. The combined weight may be even less than that of a single normal kidney. Corresponding with the diminution in size an increase in the amount of perirenal fat is usually to be noticed. In the early stages of the disease, however, there may be very little alteration in the size or colour of the kidneys, and the most prominent characteristic may be increase in the thickness of the capsule and the greater difficulty of its detachment. Even when this last condition is met with, the cortex may be very much diminished, as seen on section. Generally the surface of the kidney is roughened and granular, and of a deep reddish-brown colour. Sometimes the roughened granular surface is covered with little yellow spots, and frequently small cysts may be found near the surface of the kidney. Though the cysts are, as a rule, extremely minute, they may be from a quarter to half an inch in diameter. Occasionally small white nodules may be found similarly dotted about near the surface. The kidney as a whole is firm and resistant, being at times rather difficult to cut, owing to the increased amount of fibrous tissue. Frequently the degree of contraction of the kidney is somewhat masked by the dilatation of the pelvis, which is filled or even distended with an excessive amount of adipose tissue. On section the diminution in the size is seen to be mainly due to the diminution in the thickness of the cortex, the proportion of cortex to medulla bearing the relation of a fifth to a sixth, instead of from a third to a fourth, as in the healthy kidney. The cysts and white nodules above mentioned are more evident in the cut surface, and, in addition, cicatricial tissue may often be observed spreading inwards from the cortex. The Malpighian bodies are sometimes reduced in size as well as in number, and microscopically they are found to be irregular in shape, and situated nearer to the trunk of the artery than usual. They are frequently found immediately below the capsule of the kidney. instead of being separated from it by a short interval. The pyramidal portions of the kidney are generally of a dark colour, and white lines sometimes occupy the position of the straight tubes of the medulla, and indicate the presence of crystalline deposits of urates.

Microscopic examination brings out the changes of the kidney in a more marked manner, since triangular wedges of fibrous tissue, apparently devoid of true gland structure, are rendered more evident in stained specimens. The development of fibrous tissue is extremely irregular ; portions of gland structure, apparently in a healthy condition, may intervene ; sometimes in the triangular patches numerous nuclei are seen ; at other times the nuclei are more rare, and the tissue appears more distinctly fibrillated and organised. Compressed and atrophic tubules are occasionally found scattered amongst the new tissue, and if these contain epithelium the cells usually are in a state of fatty degeneration. The connective tissue round the convoluted tubes is very often increased in amount, and the capsules are greatly thickened by proliferation, which tends to encroach upon the space normally occupied by the glomerular tuft, and may ultimately lead to obliteration of the glomerulus. These atrophic changes in connection with the Malpighian tufts are often regarded as the earliest features of cirrhosis of the kidney, while the atrophy of the tubules and the development of the interstitial changes are regarded as secondary results.

The tubes appear, in some cases, to be denuded of their epithelium ; in others, to be somewhat distended. Occasionally in the atrophic tissue they may be plugged with colloid material, and distinct casts of considerable diameter may be found. The white nodules mentioned above are seen on microscopic examination to consist of small accumulations of epithelial cells. In the straight tubes of the pyramids the epithelium, as a rule, is normal, but they are sometimes filled with crystals of urate of sodium.

The blood-vessels of the kidney are often markedly altered ; considerable discussion has arisen as to whether these changes affecting the smallest arteries are secondary to the alterations in the kidney above described, or whether they are primary changes which precede the alterations in the gland structure.

The main changes in the small arteries is an increase in the thickness of the walls together with diminution in their calibre. This may be due to an overgrowth of the intima, occurring without material proliferation of nuclei, and may almost entirely occlude the blood-vessel. This alteration corresponds closely with the endarteritis obliterans described by Cornil and Ranvier.

Another change in the small arteries consists in the hyaline fibroid degeneration, which was originally described as arterio-capillary fibrosis. Muscular hypertrophy undoubtedly occurs at a very early stage of renal cirrhosis, and according to Dr. Dickinson, it is to be ascribed to some assumed change in the structure of the capillaries, rather than to cardiac hypertrophy, as originally believed by Sir George Johnson. It is certain that increase in the thickness of the wall of the left ventricle is invariably associated with renal contraction. Sometimes this hypertrophy occurs with some dilatation of the cavity, but in the early stages it is far more frequent for the dilatation to be comparatively slight, although the hypertrophy may be sufficient to cause alteration in the position of the apex beat. As the disease advances, and especially towards the termination, dilatation of the heart becomes more frequent; hence, to a certain extent, the position of the apex beat and the area of cardiac dulness may be taken as indications of the stage of the disease.

Etiology

Acute Nephritis.—Acute nephritis occurs mostly in young adults, and it is more frequent amongst males, probably owing to exposure. It is also more common amongst the middle and labouring classes, on account of their occupations, clothing, and habits.

Cold is one of the most common causes of acute nephritis, especially during exhaustion from work or exercise, or when the skin is actively perspiring. Among the labouring classes the danger is greatest when the work is irregular, leading to great muscular activity and subsequent chill. It has also been frequently produced by cold and wet, affecting those who are heated by hunting or by cycling, while exposure after dissipation has also resulted in this disease. Amongst children it is relatively rare to find acute nephritis attributable to cold, unless the individual has previously suffered from one of the exanthemata, notably scarlet fever.

Next in importance, as far as etiology is concerned, stand various febrile diseases, such as small-pox, measles, erysipelas, typhoid, and pneumonia. The nephritis caused by these maladies is sometimes slight and abortive, and is limited chiefly to the time of the pyrexia. Such mild cases constitute "Febrile Albuminuria." Occasionally, however, acute nephritis associated with these diseases may be accompanied by the more prominent symptoms of the serious malady, such as dropsy and hæmaturia.

Henoch has recorded four cases of nephritis which were apparently the result of chicken-pox.

The frequent connection of these diseases with renal changes has led to the employment of the term "acute infective nephritis." Micro-organisms are, however, absent in most cases of nephritis, and it is generally held that the renal changes are due to the action of toxic materials which result from the growth of specific organisms within the body.

Numerous drugs may cause acute nephritis, especially those which are eliminated by the kidney, such as cantharides, turpentine, copaiba, phosphorus, and alcohol. Mostly, however, the influence of toxic agents is limited to the production of temporary congestion, rather than of true nephritis.

Extensive injury to the skin by disease, by burns, or by a lightning stroke, may sometimes excite acute nephritis, either by direct interference with the functions of the skin, or by general depression of the temperature of the body.

Acute Nephritis after Scarlet Fever.—Some maintain that albuminuria in the course of scarlet fever indicates structural disease of the kidney, which under adverse circumstances may pass on to the formation of acute and chronic disease. Although the frequency both of albuminuria and of nephritis must be admitted, there is very little certain knowledge as to the exact causation of nephritis in an individual case, and in some epidemics renal changes are more frequent than in others. Nephritis is said to be especially likely to occur when the cervical glands become secondarily enlarged after once subsiding; the influence of a high fever has also been suggested. The actual severity of the original attack of fever appears to have no causal relation to the production of nephritis; in fact, my own experience would lead me rather to consider that nephritis is unusually common amongst children in whom the original febrile attack has been slight.

Nephritis, as a complication of scarlet fever, is uncommon during the first year of life, and the frequency increases rapidly up to the fifth year, after which time it gradually decreases. It is somewhat more frequent in males (3 to 2), and it is also more fatal to males, while the mortality is greater the younger the patient.

The disease usually occurs after the twelfth or fourteenth day, or during the early part of the third week. Occasionally nephritis is not discovered until the fourth, fifth, or sixth week, but in such cases it has probably existed for a greater length of time.

The immediate exciting cause of scarlatinal nephritis is generally held to be exposure to cold during desquamation, but recent observations indicate that cold weather *per se* has very little influence in producing albuminuria. There is, however, an apparent connection with the degree of humidity of the atmosphere. Damp, cold, or muggy days favour the development of fresh cases, while the return of bright weather is frequently accompanied by rapid improvement.

The view generally held at the present time is that the renal changes are due to irritation by some toxic material resulting from the growth of micro-organisms in the system. These changes may be almost quiescent until they receive a sudden impulse from the congestion brought about in a reflex manner through exposure to cold, or through climatic conditions.

Chronic Nephritis

Chronic nephritis is usually the result of *acute nephritis*, and occurs somewhat later in life. Frequently there is a distinct interval between the attack of acute nephritis and the first symptoms of chronic nephritis, though if the urine is tested daily small quantities of albumin may be found, either persistently or occasionally. The symptoms of chronic nephritis are mostly observed between the ages of twenty-five and forty, and in this respect the condition differs essentially from cirrhosis of the kidney (chronic interstitial nephritis), which occurs more commonly between the ages of forty and fifty, or fifty and sixty.

Scarlet Fever.—Many cases of chronic nephritis result from acute scarlatinal nephritis, and there is reason to believe that chronic nephritis may even follow this disease without the recognition of the acute stage. If the symptoms of scarlatinal nephritis are slight, and if dropsy is not present, the disease may be overlooked, and, in the absence of treatment, may become chronic.

Cold.—The influence of cold in the production of acute nephritis has already been mentioned, and there is common agreement that frequent exposure to wet, and residence in damp and cold climates, also favour the onset of the chronic form. It is somewhat doubtful, however, whether the cold acts as a direct cause of nephritis, or whether it merely increases predisposition to the disease. It has been suggested that congestion due to cold might develop an old-standing nephritis—that, for instance, after various exanthemata, more particularly scarlet fever, some permanent damage is done to the kidney, which causes no symptoms until engorgement, the result of exposure, once more starts the morbid processes.

Pregnancy.—Pregnancy has been sometimes assigned as a cause of chronic nephritis. As a rule the albuminuria of puerperal nephritis subsides soon after delivery, and when the albuminuria is persistent, there appears to be little doubt that the nephritis originated previously and independently of pregnancy.

Chronic Suppuration.—Chronic suppuration from phthisis, necrosed bone, or other cause, may produce chronic affection of the kidneys. The change that results is usually a form of lardaceous disease, but this alteration is very frequently accompanied by chronic nephritis. The lardaceous changes are as a rule more advanced in children, while the nephritic changes are more marked in adults.

Malaria.—The influence of malaria as an etiological factor for chronic nephritis is open to considerable doubt. Some authors have associated chronic nephritis with malarial districts, but there is very little to show that a pure form of nephritis may result from malarial influences. Observations made in Algiers and Bombay show, however, that in these places the association of chronic Bright's disease with malaria is as marked as it is in colder climates; hence the supposition that malarial nephritis is essentially due to exposure to cold scarcely seems tenable.

Syphilis.—The connection with syphilis is fairly close, and chronic changes within the kidney may occur independently of the growth of renal gummata.

Toxic Agents.—In some cases chronic nephritis has been attributed to the use of mercury, while lead is also said to cause a form of chronic inflammation of the kidneys of the same nature. The connection between chronic nephritis and lead poisoning is not so strong as between gout and lead poisoning, which are so often associated with cirrhosis of the kidney.

Alcohol.—The relation of chronic alcoholism to chronic nephritis is less open to dispute, though it is more likely to lead to renal cirrhosis than to chronic nephritis.

Secondary to other Conditions.—Chronic nephritis occurs fairly commonly as the result of chronic diseases of the urinary passages. Chronic stricture of the urethra, purulent cystitis and prostatitis, and calculous pyelitis may give rise to chronic nephritis associated with lardaceous changes.

Renal Cirrhosis

In a disease which is so chronic in its nature, the etiology necessarily becomes somewhat uncertain. It is often impossible, in any particular case, to ascribe the origin conclusively to any definite exciting cause.

Age.—It is very rare to find this form of kidney disease amongst children, or even amongst young adults. Towards middle life, however, the tendency to cirrhosis is greatly increased; the majority of cases occur between the ages of forty and sixty, while from thirty to forty the proportion is about equal to that which occurs between sixty and seventy. It must be remembered that this form of kidney trouble is likely to escape observation; and it may have existed for years previous to the actual recognition. Most of the cases of albuminuria met with in assurance work fall into two classes, both marked by the presence of traces of albumin, and by the slight character or the total absence of symptoms. The age of the proposer is of importance in differentiating these two classes. While slight albuminuria during early life is often to be regarded as functional or intermittent, the slight trace of albumin in later middle age is generally the result of contracted kidney.

Sex.—Males are more frequently affected than females. According to Fagge the proportion is almost exactly in the ratio of two to one. Others have placed the proportion more highly.

Heredity.—Although the hereditary character of renal cirrhosis has attracted the attention of numerous observers, the hereditary tendency is not so marked as in the case of phthisis or cancer. It is frequently interesting to note the occurrence of cirrhosis or other forms of kidney trouble in various members of a family, and although it is customary to regard this association as pointing to the hereditary character of cirrhosis of the kidney, it may be questioned whether it does not point rather to the hereditary character of the conditions likely to produce the disease. This contention is largely supported by the frequent association of cirrhosis of the kidney with gouty tendencies.

Gout.—The intimate connection of renal cirrhosis with gout has long been recognised. It is generally held that gout predisposes to the development of renal cirrhosis, and I have often seen the gradual development of albuminuria with repeated attacks of gout. It has been held, however, that gout may be the consequence rather than the cause of the renal affection, and that it results from the failure of the kidney to perform its normal eliminative function. It is far more probable that renal cirrhosis follows from the constant irritation of uric acid in the solid form within the substance of the kidney. Although allowing that gout may occasionally be consecutive to cirrhosis of the kidney, I hold that it is far more frequently to be regarded as the cause. It is mainly in recognition of the association of these conditions that most assurance offices are in the habit of charging an extra premium in cases of repeated gout.

Dyspepsia.—Like the preceding condition, dyspepsia has been regarded both as the cause and as the result of renal cirrhosis. While admitting that disorders of digestion may frequently be responsible for transient forms of albuminuria, there is some doubt whether chronic renal affection is to be started in this way, or whether when prolonged dyspepsia is found to be accompanied by permanent slight albuminuria, dyspepsia is not to be looked upon as a symptom of the disease rather than as an etiological factor.

Habits.—Renal cirrhosis frequently arises in patients who have been accustomed to eat and drink to excess. Large quantities of nitrogenous foods lead to an undue amount of work being thrown upon the kidney. If at the same time these patients take a relatively small proportion of liquid the urine becomes concentrated, and the tendency to the formation of uric acid and of oxalates is increased.

Neuroses.—The depression resulting from emotional causes, prolonged anxiety, worry, or grief, seems to have some direct influence, although it is extremely difficult to explain how disease of the kidney is thus produced. It is possible that the nervous influence may disturb the digestive system, or may lead to intemperate habits. Sometimes mental depression may merely favour the rapid development of pre-existing disease; sometimes it may contribute to gouty attacks; but whether nervous depression by itself can produce cirrhosis remains somewhat doubtful. In spite of the frequency with which mental anxiety appears to be distinctly associated with this disease, there may be no true etiological connection, inasmuch as cirrhosis, a disease of middle age, occurs at a time when mental disturbances, from financial difficulties or other causes of anxiety are likely to arise.

Lead Poisoning.—Similar uncertainty surrounds the supposed connection between lead poisoning and cirrhosis of the kidney. There is no doubt about the frequent association of lead poisoning and gout, and many observers have attempted to explain the influence of lead poisoning as contributing to the occurrence of gout, which in turn leads on to renal cirrhosis.

Climatic Conditions.—Cirrhosis of the kidney appears to be more frequent in temperate climates; hence it has frequently been held that it is favoured by damp and by rapid alterations of temperature.

Chronic irritation of the bladder or of the urethra by stricture, or of the pelvis of the kidney by means of a renal calculus, may occasionally induce cirrhosis of the kidney, but far more commonly these causes lead to consecutive nephritis.

Clinical Features of the Different Types

Acute Nephritis.—The commencement of acute nephritis is indicated by chills or slight rigors, which are followed by a varying period of a typical pyrexia. The temperature may be only slightly raised, or it may reach 103° or 104° Fahr. The pulse-rate is proportionately raised and its volume may be increased. The tongue is furred and the bowels are constipated. When the nephritis originates in one of the infectious diseases (with the exception of scarlet fever) the onset is rarely marked by such definite symptoms, and unless the urine is tested the commencement may escape observation.

The Urine.—From the first there is notable diminution in the quantity of urine passed, and occasionally the excretion of urine is almost totally arrested. When the disease is fully established the amount generally varies from 6 to 16 ounces in the twenty-four hours, and there is frequent desire to micturate, only a few drops being passed at a time with much straining. The specific gravity of the water may be as high as 1030 or 1040. When improvement commences and the quantity is augmented, the specific gravity falls more nearly to the normal. Generally, during the acute stage the reaction of the urine is acid, and quantities of albumin are present. The colour is dark reddish brown, turbid and smoky, and the sediment, which is abundant, is composed largely of blood casts, blood corpuscles, renal epithelium and granular urates, or crystals of uric acid and calcium oxalate. Blood corpuscles and epithelial cells generally predominate, but casts are always present, though their prevailing type changes as the disease progresses.

At first blood casts and epithelial casts are especially numerous, but when the case is becoming more chronic they are replaced by granular casts and fatty casts, which accordingly afford valuable indications of the stage of the disease. In spite of the high specific gravity of the urine the daily elimination of solids is generally diminished. The urea is decreased in quantity from 25 per cent to 50 per cent, and the chlorides similarly undergo great diminution.

Pain.—Complaint may be made of uneasiness or discomfort in the region of the kidneys. This may amount to actual pain, extending along the ureters to the bladder, but pain, when present, is mostly connected with the act of micturition, rather than with the degree of inflammation of the kidney. As a rule, renal affections of prolonged course are not associated with lumbar pain, and to a certain extent this fact is to be explained by the comparative absence of nerves of common sensation in connection with the kidney. There is, it is true, a free supply of sensory nerves to the capsule and the pelvis of the kidney, but these are only likely to be influenced by affections causing sudden distension of the kidney; with inflammatory diseases of the kidney pain or discomfort, if present, is generally reflected to some other site.

Dropsy.—When acute nephritis is due to cold, dropsy is one of the commonest and earliest indications, and it is frequently the first which attracts attention. In mild cases it may commence about the legs and the cheeks; the latter may be found puffy on first rising. The œdema usually commences in the lower eyelids, and the conjunctivæ are affected at the same time, hence the eyes appear brighter than usual. The œdema may spread rapidly to the trunk and the extremities; even in mild cases the feet may be swollen towards evening when the œdema has, to a great extent, disappeared from the face. When the dropsy is only slight the general appearance is much like that of chlorosis. It is more common, however, to find the whole trunk œdematous, the œdema generally being most marked in dependent parts. Considerable swelling is often found at the lower part of the back, constituting the well-known lumbar pad. The genitals, especially the prepuce, may be affected, and the œdema may be so excessive as to interfere with micturition.

As the subcutaneous tissue becomes infiltrated the serous sacs may be involved. The abdominal cavity may contain fluid, and occasionally an increase of serum may be detected in the pleura and in the pericardium. Still more dangerous, but fortunately more rare, is œdema of the glottis, which develops with extreme rapidity, and may lead to asphyxia.

Digestive System.—Interference with digestion is frequent. The appetite is bad, especially during the pyrexia; the tongue is furred, and there is usually constipation, though later this may be replaced by diarrhœa independently of treatment. This diarrhœa has been attributed to a natural effort to eliminate excretory matters. During the early stages nausea and vomiting are also frequent; they may possibly be reflex symptoms, but at a later stage, in all probability, the vomiting is of uræmic origin, and when uncontrollable it presents a serious complication.

Circulatory System.—It has generally been held that the circulatory system is not materially affected in the early stages of acute nephritis, and the changes connected with the heart and smaller arteries are commonly considered to occur with chronic renal affections, or to develop with the transition from the acute to the chronic stage. Dr. Dickinson, however, has suggested that from the beginning of acute kidney trouble there is some alteration of the wall of the capillaries, and he considers that this alteration, if permanent, contributes largely to the subsequent hypertrophy of the arterioles and of the left ventricle. Sometimes acute enlargement of the left ventricle may occur, but this is usually a transient feature.

Anæmia is an early and characteristic symptom; it may result from the loss of albumin or from great hæmaturia. When the pallor is very rapidly developed in connection with dropsy, it is in all probability due rather to the infiltration of the tissues with serum than to blood changes. In advanced cases of acute nephritis the red corpuscles of the blood are always reduced in number; the albumin is diminished, and the serum contains a large proportion of water; in addition, it is common to find in the blood either urea, uric acid, or both, and perhaps other urinary derivatives. Pericarditis may occur, and when the effusion is purulent in character the disease nearly always terminates fatally. In acute nephritis it is very rare to meet with epistaxis or to find hæmorrhages in the retina.

Respiratory System.—Alterations in the respiratory system only occur as complications. Pleurisy, bronchitis, and pneumonia may develop in severe cases, and may hasten a fatal termination; the pleurisy is especially dangerous since it is frequently purulent. It is not uncommon, however, for mild cases of acute nephritis to be associated with slight pulmonary engorgement; the degree of engorgement mostly varies inversely with the amount of fluid in the pleural cavity. Slight congestion of the lungs is not necessarily a serious complication.

Nervous System.—The effects upon the nervous system may develop with considerable rapidity. In the early stages headache is commonly present; it may merely be a dull sense of weight, or it may be very intense. When the urine is very much reduced uræmic convulsions may suddenly appear, and in some cases they are of a hemiplegic type. During the convulsions the temperature may rise, but afterwards it is mostly subnormal. The convulsion is often succeeded by coma. Sometimes several convulsions occur at short intervals, the patient remaining comatose in the intervals; and the depth of the coma may increase after each attack of convulsions. Occasionally after convulsions there may be partial or complete blindness. Uræmic amaurosis is mostly a transient symptom, and in its short duration differs from the amaurosis of chronic forms of kidney disease. The uræmic convulsions are the expression of the retention of toxic materials, and unless the case terminates early in a convulsion the nervous symptoms usually speedily pass away.

Course and Duration.—The initial rise of temperature may continue for four or five days, or at most for a week, but very often the patients are first seen when the temperature is normal or only slightly raised. The early symptoms which are then noted are those of dropsy and of alteration in the urine. The dropsy varies with the amount of urine, hence in the first few days the dropsical condition is generally more marked than later; sometimes, however, when the suppression of urine is progressive instead of sudden, the dropsy may reach its highest stage towards the end of the second week. In most attacks the dropsy develops with great rapidity, and undergoes considerable improvement with the re-establishment of the work of the kidney. Under favourable conditions there is speedy diminution in the amount of albumin, blood corpuscles, and casts, and the urine, from being a deep red or smoky tint, regains its normal appearance in a few days. If, on the other hand, the quantity of urine progressively diminishes, secondary affections of the nervous system are likely to arise, and the patient may die from acute uræmia.

Occasionally the onset is more gradual, and the symptoms are less marked. There may be progressive diminution in the quantity of urine, gradual increase in the extent of the dropsical effusions, and indications of secondary affections of the lungs or of the various serous membranes. The favourable progress of cases of acute nephritis is sometimes interfered with by distinct relapses, in which the symptoms resemble those of the primary attack. Such relapses are mostly attributed to alterations of temperature, exposure to cold, or to the premature use of ordinary forms of diet. In all probability these relapses indicate an extension of inflammation to some portion of the kidney previously unaffected, and hence they constitute not only an immediate danger, but they further imperil the patient's chances of ultimate recovery.

With cases that are doing well it is generally found that the amount of urine exceeds the normal quantity, since the kidneys have to remove a large quantity of dropsical material. Hence the colour of the urine is diminished, the specific gravity is reduced, and the amount of albumin decreases rapidly, the decrease affecting the total quantity of albumin passed in the day, as well as the percentage in any particular specimen. As the patient progresses towards recovery the nature of the sediment alters, epithelial cells and free blood corpuscles become less numerous, and the epithelial and blood casts are gradually replaced by hyaline and granular casts, which in turn decrease in number, and may ultimately disappear.

Although the above is true of a large number of cases of acute nephritis, it unfortunately frequently happens that after a certain degree of rapid progress the improvement appears to come to a standstill, and although the amount of urine passed differs little from the normal quantity, yet it contains traces of albumin which may vary slightly from day to day. The casts also become more granular, and fatty casts may be found. These indications of lack of progress are sometimes accompanied by persistence of slight dropsy. These symptoms always cause anxiety about the ultimate recovery of the patient, as they indicate a tendency to a gradual transition from the acute to the chronic form.

From the above account it will be seen that it is impossible to predict the course or the duration of any case of acute nephritis. Towards the end of the first week the improvement may be rapid, and the patient may seem to be convalescing, yet it is not safe to build too much upon such rapid improvement, and the patient must be kept in bed, and the diet must be regulated, even though the albumin has disappeared, and convalescence appears to be established. Usually the duration of an acute attack varies from two to six weeks, but when relapses occur recovery may be delayed for eight weeks or more. If after this time albumin is still found, while the hæmaturia has disappeared, and if casts, especially granular and fatty casts, are still present, the case must be regarded as having passed into the chronic stage. When a fatal termination occurs it may be due to the extent of the dropsy or to the severity of other complications. Great accumulations of fluid in the pleura or pericardium, or, in rare cases, œdema of the larynx may be the immediate cause of death. Frequently death may occur in the course of acute nephritis as the result of œdema of the lungs, or from a combination of œdema and pneumonia. Sometimes acute inflammation of the pleura or of the pericardium may appear to give rise to more urgent symptoms than the chronic effusion of dropsical fluid, at any rate they cause more distress and pain, and they add to the risks by interfering with the patient's rest. Many cases terminate with acute uræmia, sometimes during the first attack of convulsions, sometimes from a succession of attacks, and in rare cases death may be due to gradual failure of the heart's action, owing to dilatation of the left ventricle.

The immediate cause of death appears to depend to some extent upon the age of the patient; in children death mostly results from inflammation of the respiratory organs, while in adults it may be due to uræmic poisoning, or to one of the direct consequences of dropsy. Dangerous erysipelatous inflammation or abscesses in the cellular tissue may follow acupuncture or incisions, obstinate vomiting, also, the result of uræmia, may hasten the end.

Acute Nephritis after Scarlet Fever.—Some of the clinical features of acute nephritis after scarlet fever differ slightly from those already described, and call for brief consideration. The onset of scarlatinal nephritis is generally marked by definite symptoms, although it occasionally appears to commence insidiously. As a rule there is some rise of temperature. This may be very slight, and occurs most commonly towards the end of the second or during the third week. The initial pyrexia may be preceded by headache, loss of appetite, and pallor, which may be associated with constipation. These symptoms are frequently followed closely by rapid diminution in the quantity of urine passed, by alteration of its specific gravity, and by the appearance of albumin and blood in the water. In exceptional epidemics there appears to be little reason to doubt that scarlatinal nephritis may occur without albuminuria; at all events, numerous observations have been made of cases of dropsy without albuminuria.

Dropsy.—General œdema may be the first symptom to attract notice, and it is more common in cases marked by total or relative suppression of urine. The œdema is usually first noted around the eyes, and it may rapidly extend so that after a few hours the child is almost unrecognisable. In severe cases, when the dropsy is general and extreme, fissures may form and lead to extensive excoriations. Although the œdematous condition is not generally associated with discomfort other than that due to the limitation of movement, yet tenderness may be complained of when the tension is great. Both Caiger and Turner, speaking from experience of cases treated within fever hospitals, find that dropsy is not a prominent symptom when scarlatinal nephritis develops while the patient is continually under observation in the wards.

The abdominal cavity may become affected by dropsical effusion, and occasionally similar collections of fluid may be found in the pleura and pericardium. These may cause great anxiety, since there is a marked tendency for inflammatory effusions to become purulent, a tendency which is greater than that in acute nephritis.

Circulatory System.—The alterations of the pulse with the initial rise of temperature have been already mentioned. As the disease progresses the pulse generally becomes more slow and perhaps irregular, while the tension is increased. Henoch regards irregularity of the pulse as an indication of danger from uræmia. With cases which tend to the establishment of chronic nephritis the pulse undergoes but little improvement; in fact, a continued high tension may frequently be taken as an indication of permanent renal changes. Cardiac hypertrophy is one of the most common forms of circulatory change in connection with scarlatinal nephritis. In a large majority of cases the apex beat of the heart is in quite an early stage displaced outwards and downwards. When cases of scarlatinal nephritis are undergoing improvement the apex beat quickly returns to its original site. The rapidity with which this occurs favours the idea that the displacement of the apex beat may, to a large extent, be due to dilatation rather than hypertrophy.

Cardiac dilatation adds to the danger, as it favours pulmonary changes; it is frequently followed by œdema of the lung and by urgent dyspnœa. The onset of acute cardiac dilatation may sometimes be recognised by the alteration in the character of the pulse, which becomes rapid, thready, and weak.

Respiratory System.—Œdema of the lung constitutes one of the greatest dangers of scarlatinal nephritis. Pneumonia and pleurisy are frequent, and, as already noted, the tendency of pleuritic effusion to become purulent is very marked.

Uræmia.—The indications of uræmia are particularly prone to occur in connection with scarlatinal nephritis, and they are extremely difficult to differentiate from many of the symptoms referred to above. In all probability the apathy, sickness, headache, restlessness, and dyspnœa are the expression of uræmic poisoning, and these symptoms are most common when there is marked diminution in the amount of urine eliminated. Severe symptoms of uræmia, however, may occur independently of reduction in the quantity of water passed, and may even arise in dropsical cases when, after temporary suppression, the excretion appears to have been fairly re-established. This has been explained by the reabsorption of nitrogenous material from the subcutaneous tissues. Although uræmia necessarily adds largely to the risk of scarlatinal nephritis, it does not appear to be so frequently fatal as in other forms of nephritis.

Course and Duration.—Under appropriate treatment improvement speedily follows in a large majority of cases, the improvement being most marked towards the end of the first week from the commencement of the symptoms. Albumin, however, is usually found in the water long after other symptoms have passed away. Indeed, albuminuria sometimes continues from four to six weeks; if the albumin lasts longer, chronic nephritis has probably become established. The steady improvement is occasionally interrupted by relapses; the water becomes again very small in amount, high coloured and albuminous, and more rarely the dropsy undergoes similar marked increase.

Only a small proportion of cases pass directly into chronic nephritis. The majority recover completely in from two to three weeks. On the other hand, when scarlatinal nephritis has once occurred, the liability to subsequent attacks of nephritis is more marked.

Chronic Nephritis.—It is only in exceptional cases that the transition from acute nephritis to chronic nephritis can be watched, so that the clinical picture is complete in all its details; more commonly the patients come under observation when the disease has already been of long standing. Some of the earliest indications are to be found in the urine, in dropsy, and in anæmia, which is frequently profound.

The Urine.—The quantity of urine passed is to a certain extent dependent upon the degree of dropsy, and, although the daily quantity is subject to great variations, it is on the average less than the normal amount. The decrease, however, in the early stages is not very considerable, and it is by no means comparable with that which occurs in acute nephritis. Although the amount may be reduced to half the normal quantity or even less, cases of complete suppression are comparatively rare, and, as a rule, anuria only occurs shortly before the fatal termination. Usually, as the dropsy increases the amount of urine progressively decreases. In the early stages the specific gravity is slightly lower. If followed from its commencement in an acute attack, as the signs of hæmorrhage decrease the urine presents a cloudy deposit; this is generally considered to be of serious import. This deposit consists largely of casts, which, in the early stages, are mostly of the hyaline variety, though with any subacute inflammatory complication epithelial casts and blood casts may be superadded. At other times the casts present oil globules and evidence of granular degeneration. In chronic nephritis casts are generally present in very large quantity, and are readily detected. In addition, however, numerous leucocytes and, more rarely, red blood corpuscles may be found. Renal epithelium is sometimes present, and it is frequently somewhat opaque or cloudy, indicating the existence of degenerative changes. Occasionally, also, there is much granular débris—sometimes floating freely in the urine, more often collected around the casts.

In the early stages of chronic nephritis albumin is always present in considerable quantity. It has been stated that in cases of large white kidney there are on an average larger quantities of albumin than with the spotted or contracted kidney; this, however, is certainly not always the case. As the disease progresses the quantity of urine may increase to the normal, or may even be slightly above the normal amount; at the same time the urine becomes pale, the specific gravity falls, and the amount of albumin is diminished. Throughout the disease the quantity of urea is reduced.

Within certain limits it is possible to estimate the degree of renal change by the alterations in the urine. As the contraction proceeds the amount of urine becomes greater, while the specific gravity is diminished and the quantity of albumin is also decreased. These changes, therefore, tend to render the urine somewhat similar to that which is passed by patients with a contracted or cirrhotic kidney.

A curious result of chronic nephritis is that the kidney loses its normal power of eliminating various drugs, for example, iodide of potassium, salicylic acid, and quinine. The power of transforming benzoic acid into hippuric acid is also stated to be impaired.

Dropsy.—The dropsy of chronic nephritis usually develops slowly, and in the early stages is not excessive. At the commencement the puffiness of the face, which attracts the patient's attention on first rising, gradually subsides during the day, while the ankles increase in size towards the evening. When the disease is fully established the dropsy may affect not only the lower extremities, but the whole of the subcutaneous tissue, and it may also involve the serous cavities. When patients are kept in bed swelling of the scrotum or of the back may develop. When the œdema has once claimed attention it is generally one of the most difficult symptoms to deal with, since it rarely disappears entirely, and sometimes, with little warning, it increases rapidly; not uncommonly the distension may result in cracking of the skin, which allows the escape of the dropsical effusion. Sometimes the distension interferes with nutrition and sloughs may form. The effusion within the abdominal cavity is occasionally so considerable as to impede respiration and circulation.

Œdema of the glottis may develop with great rapidity and may cause death.

In milder cases the swelling of the legs or scrotum may show but little variation until the supervention of subacute renal inflammation, owing possibly to exposure or to some irregularity of diet.

Anæmia.—The anæmia of chronic nephritis is always very noticeable, and it appears probable that some of the most troublesome symptoms are indirectly the result of anæmia, for example, the dyspepsia, the severe headache, and the frequent shortness of breath.

Circulatory System.—There is generally dilatation and hypertrophy of the left ventricle, and some hypertrophic and degenerative change affecting the smaller arteries. The extent of these changes increases as the kidney diminishes in size. Sometimes acute dilatation of the ventricle occurs and is accompanied by dyspnœa and cyanosis. Far more commonly the dilatation is accompanied by hypertrophy, which is to a large extent compensatory. The rapidity of the pulse is usually increased, and the tracings are marked by dicrotism. That the blood pressure is not markedly increased in chronic nephritis, as compared with cirrhosis of the kidney, is shown by the rarity of retinal hæmorrhages and cerebral hæmorrhages in the former. When these supervene they indicate that the kidney has already undergone contraction.

Muscular System.—As the dropsical effusion increases there is marked loss of strength, which may at first be attributed to the weight of the limbs. The degree of wasting may not be apparent until the dropsical effusion in the lower extremities is diminished, but frequently there is striking contrast between the thin flabby upper arms and the enormous size of the hands and wrists.

Digestive System.—The digestive system appears to be early implicated. Patients have little appetite and are apt to be fanciful about their diet. They may have a distaste for meat, and frequently they attribute their dislike to certain food to impaired digestion. This distaste for food may proceed to actual nausea and vomiting. The material vomited may consist largely of water, and it has been suggested that it may result from œdema of the mucous membrane of the stomach. In all probability, however, the vomiting of chronic nephritis is to be regarded as one of the indications of uræmia. In the later stages of the disease diarrhœa is occasionally excessive, the motions not only being more frequent, but containing large quantities of liquid. These symptoms are usually very exhausting, and they are extremely difficult to treat. They may defy all therapeutic measures and contribute largely to the weakness from which the patient ultimately sinks. Occasionally ulceration of the intestine occurs, and the diarrhœa then alters in character—pus, blood, and mucus being present.

Nervous System.—Notwithstanding the diminution in the excretory work of the kidney, symptoms of acute uræmia are comparatively rare with chronic nephritis, and it has been suggested that this is due to the retention of nitrogenous waste in the dropsical fluid. Acute uræmic symptoms have been observed when, under the influence of vapour baths, the reabsorption of the dropsical effusion has commenced, and this occurrence favours the idea that this reabsorption throws into the circulation a large quantity of toxic material. Nevertheless, the rarity of acute uræmic symptoms with cases of excessive dropsical effusion is noteworthy, and suggests that the excessive effusion serves to protect the system from the results of the impaired excretory work of the kidney. Symptoms of chronic uræmia are, on the contrary, relatively frequent, the chief of these being severe headache, impaired mental activity, frequent vomiting, dyspepsia and diarrhœa, and occasional attacks of an asthmatic nature.

Reference has already been made to the occasional occurrence of retinal changes, but, in addition, amaurosis may sometimes be developed independently of any retinal change.

It is somewhat doubtful whether the following symptoms are to be regarded as uræmic or as the result of disturbances of the nervous system; but it is fairly frequent to find that patients suffer from numbness in the fingers, itching, pins and needles, or even burning pains in the hands and arms. These symptoms are frequently seen in connection with advanced chronic nephritis, where contraction of the kidney has probably occurred.

Secondary Inflammations.—Secondary inflammations are mostly the cause of death in cases of chronic nephritis, and they may affect either the external or internal organs. There is marked tendency to erysipelas and to gangrene, and this tendency must be borne in mind whenever the skin has been broken. Notwithstanding the utmost antiseptic care, erysipelas and gangrene frequently supervene.

In connection with the digestive system, towards the termination of the case, severe hæmorrhages may occur, either from the stomach or from the bowel.

Of the pulmonary complications secondary pneumonia is the most important, while the tendency to pleurisy and to the development of pus within the pleural cavity is relatively frequent. The degree of engorgement of lung varies greatly, usually indeed in inverse proportion to the degree of effusion within the chest. It is not uncommon to find pericarditis develop with considerable rapidity, and frequently a pericardial rub may be heard even when the patient is not complaining of pain. The pericarditis of chronic nephritis is not usually associated with much effusion; occasionally, however, the whole pericardium may be distended with muco-purulent fluid. Abortion is said to be frequent, and has been attributed to premature detachment of the placenta, or to the development of white nodules, probably degenerative, within this organ.

Abnormal Types.—Sundry abnormal types of nephritis may occasionally be met with. One of these constitutes the chronic hæmorrhagic Bright's disease without œdema which has been described by Wagner; this type is marked by the frequent recurrence of periodic hæmorrhages. These attacks only last a few days at a time, though they may return at intervals of a week or a month. Between the attacks the urine is in every respect similar to that which is characteristic of contracted kidney, and the general health suffers very little. In some cases tertiary syphilis may also be present, but cases of this type are so uncommon that it is impossible to state whether or not they have any dependence upon syphilis.

Another variety, which is not so rare, presents symptoms of acute hæmorrhagic nephritis of sudden development in the course of the chronic disease, and this type is especially prone to be mistaken for acute nephritis. Cases marked by these intercurrent symptoms frequently run a short course. There is some reason to believe that in many cases this form of acute hæmorrhagic nephritis is a true inflammatory process constituting an extension of the original disease, and, when it is remembered that in cases of chronic nephritis certain areas only of the kidney are affected, it will be readily understood that the healthy intervening spaces may simultaneously become the subject of an acute attack.

Anomalous cases of chronic nephritis sometimes occur which exhibit only some of the prominent symptoms, such as anæmia, dropsy, and dyspepsia; but though the patient may be free from more obvious symptoms, yet the microscopic examination of the urine indicates the presence of granular casts, renal epithelium, and granular débris characteristic of this disease. In these cases, in all probability, the area affected is small and circumscribed, but the changes are those of chronic nephritis.

Course and Duration.—From what has already been said of the varying types of chronic nephritis, it is obvious that the duration and prognosis of this disease will differ considerably. When the disease can be traced onwards from an antecedent acute nephritis the duration may be almost indefinitely prolonged. The albumin may diminish after some weeks or months, and may even disappear entirely. In such cases, however, there is very little doubt that a certain portion of the kidney has been permanently damaged, and that the disease may recur at a later period.

With patients where dropsy is a marked feature from the commencement, and where the initial inflammatory stage cannot be determined, the duration is exceedingly variable. The majority of cases terminate within a year or two, owing either to the enfeeblement produced by impaired nutrition, or to the drain upon the system from the extreme dropsical effusion; as has been already indicated, the termination may also be preceded by one or other of the secondary inflammations. Occasionally the duration may be considerably longer, and in rare instances, although without a doubt the patients are suffering from chronic nephritis, a fair amount of general health may be maintained during a period of five to ten years. Dropsy is the symptom which is the most persistent in connection with chronic nephritis, but although this may be extreme, and may even threaten life, yet under exceptional circumstances it may entirely pass away, and the patient may resume a condition of apparent health marred only by the presence of albuminuria and anæmia. This condition of apparent health may be prolonged until exposure or some irregularity of life may once more start active inflammatory changes, when the clinical picture again assumes the urgent characteristics.

Renal Cirrhosis.—The most valuable symptoms, from the diagnostic point of view, connected with renal cirrhosis may be briefly summarised. There is generally an increase on the quantity of urine passed, and very little tendency to dropsical effusions. The loss of albuminuria is variable; sometimes albumin may be absent for days together, but the amount is always small. As a rule casts are difficult to find. Dyspeptic and nervous symptoms occur early. The leading symptoms of advanced cases are those indicative of uræmia.

The symptoms may be conveniently considered under three classes:—

I. The early or albuminuric stage, in which few indications can be detected apart from the occasional appearance of albumin and the increase in the daily amount of urine.

II. The fully matured stage, when the renal trouble becomes more marked, the arteries thickened, and the left ventricle hypertrophied. In this there may be dyspeptic and neuralgic troubles, yet as a whole the health is not very markedly impaired.

III. The last stage, tending towards the fatal termination, when the eliminative work of the kidney fails, the ventricle loses its force, and the various physiological systems in turn show evidence of impaired work.

I. The onset is insidious and the symptoms may be misunderstood, if they do not entirely escape observation. Frequently the disease has reached an advanced stage before there is the slightest suspicion of the gravity of the malady, it may indeed remain unrecognised until an attack of uræmic convulsions supervenes, and several cases have been recorded in which the nature of the disease was wholly unsuspected until post-mortem examination revealed the contracted kidneys. The indication that is most likely to attract attention is the increase in the quantity of urine. Consideration of the habits and of the family history may then throw some light upon the nature of the case. A gouty family history is often associated with small traces of albumin indicative of cirrhosis of the kidney. Sometimes the family history may point more distinctly to the probability of renal cirrhosis, since this form of kidney affection is somewhat more likely to occur in those with hereditary tendencies. The other early symptoms are generally found to be connected with the digestive system and the nervous system. The appetite is frequently diminished, and the patient complains of impaired digestion and flatulent distension. The early dyspeptic symptoms are rarely severe; the vomiting and diarrhœa which are so often associated with cirrhosis of the kidney belong to a later stage.

Of the symptoms connected with the nervous system headache and neuralgic pains are common. The neuralgic pains usually affect the occipital region, though neuralgia at the vertex or the frontal region may sometimes be met with. The pain, although not very severe, is more persistent than in the commoner forms of neuralgia. In a later stage sleep may be interfered with by these neuralgic pains, but as a rule the pain is most intense early in the day, and tends to diminish at night. Neuralgic pains resembling sciatica may supervene, but by far the most common type is that which imitates simple trigeminal neuralgia.

In the early stages giddiness may occur quite suddenly. It may be only momentary, and it may not cause more than a very transient vertigo with slight staggering gait. Occasionally it is more severe, and may cause the patient to fall to the ground. When these attacks have once occurred they are liable to return at fairly frequent intervals.

When any of the above symptoms have led to further inquiries, it is common to find that patients will admit having to get up at night once or twice to micturate, and they may probably realise that they are more frequently disturbed even during the day. It is by no means uncommon for this increased frequency of micturition to cause dread of diabetes. The actual amount of urine that is passed is generally considerably increased, though with the earliest stage of the disease the quantity may be very little more than normal. In extreme cases, however, twice or even three times the normal quantity may be passed in the twenty-four hours. The urine is light in colour, transparent, and generally, even on standing, gives only a very scanty, light, cloudy deposit. The specific gravity is lower than normal, from 1005 to 1010 or 1012; it will vary with the amount of water passed.

Throughout the history of a case of cirrhosis of the kidney the amount of albumin is small, and in the early stages it may be entirely absent for several days at a time. The albuminuria may possibly follow a cyclical course, being found after exercise or after meals, while it is absent in specimens that are passed in the early morning. Occasionally the mid-day specimen may be free from albumin, while the morning specimen contains a trace.

In the scanty cloudy deposit octahedral crystals of oxalates may frequently be met with, and they may be associated with uric acid. The urea passed is often reduced, though relatively large quantities may be eliminated. Renal casts are not numerous, they are mostly small and hyaline, but larger casts may sometimes be found, occasionally containing granular débris, or even atrophied renal epithelial cells. Acute inflammatory exacerbations may occur, but they are less frequent than with chronic diffused nephritis.

Changes in the circulatory system are found early. The pulse of cirrhosis of the kidney is fairly resistant, the degree of compression being roughly estimated by the amount of pressure required to arrest pulsations. The sphygmographic tracings are extremely characteristic, although high tension may be met with in connection with some other conditions, as with diabetes, with hysteria, or with atheroma.

The apex beat of the heart is displaced outwards and downwards. In addition there is accentuation of the cardiac sounds. The second sound heard over the aortic valves is especially affected, and reduplication is frequent. Late in the disease some dilatation of the right ventricle may cause further increase in the area of cardiac dulness. Epistaxis may occasionally be an early symptom, but in my experience it is more commonly met with in the later stages.

II. When the renal alterations are more fully established, many of the symptoms above enumerated will be more pronounced, and others may be superadded. Thus the dyspeptic symptoms are more likely to be associated with nausea and vomiting, and the vomiting may be more frequent in the early morning. Occasionally diarrhœa ensues, and, like the vomiting, it appears to occur spontaneously. As the disease progresses the amount of urine increases, while the specific gravity becomes more persistently low. The pale yellow colour of the urine is extremely characteristic of marked advance of the disease, and it is associated with further diminution in the elimination of urea and phosphates. Before the onset of uræmic convulsions the amount of urine may be considerably reduced; hence it is important to note any alteration in the daily excretion of urine. Diminution in quantity and the supervention of headache must always give rise to anxiety.

Respiratory System.—In advanced cases of renal cirrhosis difficulty of respiration forms a prominent symptom, and it is very frequently attributable to changes affecting the lungs and pleura. These changes can often be indirectly traced to alterations in the circulation, which will account for rapid œdema or for accumulations of fluid within the pleural cavity. In addition to these symptoms, however, in renal cirrhosis, and more rarely in chronic nephritis, "uræmic dyspnœa" may occur more suddenly and with greater urgency.

Although the symptoms resemble those of spasmodic asthma, both in the suddenness of their onset and in the completeness with which the attack may pass off, yet they do not give way before the same forms of treatment.

The variety of uræmic dyspnœa which has most prominently come under my observation is that in which there has been œdema of the lung or fluid in the pleural cavity. The difficulty of breathing commences usually at night, and the patient sits up in bed struggling for breath. Sometimes the respirations are accompanied by sibilant râles, which are apparently the result of bronchial spasm. At other times, although the breathing is equally hurried and laborious, it is accompanied by loud puerile respiration. When dyspnœa is associated with œdema of the lungs, although the attack may commence suddenly and may to a large extent pass off after a few hours of intense distress, yet the respirations continue to be more rapid than in the normal condition, indicating that there is some permanent interference with the work of respiration.

Cardio-vascular System.— With the advance of the disease there is increased dyspnœa on exertion, which, in many cases, is due rather to weakness of the circulation than to obstruction from pulmonary changes. Frequently, however, the two conditions co-exist, and the cardiac failure leads to engorgement of lung, which in turn gives rise to dilatation of the right side of the heart. Apart from dyspnœa the main symptoms likely to arise from cardiac hypertrophy are those of headache, ringing in the ears, giddiness, palpitation, and perhaps angina pectoris. These symptoms as a rule occur during the night or follow extreme exertion or other form of excess. During the early morning hours they gradually pass off, so that the patient doses, and wakes feeling fairly comfortable. Towards the end the palpitation and dyspnœa may form the most prominent symptoms, the rhythm of the heart becoming very markedly altered, and the gallop-rhythm relatively frequent. At this time the pulse may frequently lose somewhat in tension, and the sounds of the heart become less accentuated. When the heart's action is fairly regular the sounds of the heart may, however, become louder than usual, and both the first and the second sounds are frequently reduplicated.

One consequence of the hypertrophy of the left ventricle requires special mention, namely, the tendency to the rupture of blood-vessels which have undergone degenerative changes. This may give rise to severe epistaxis, to apoplexy, and sometimes, but more rarely, to gastric or intestinal hæmorrhages. Less commonly rupture of vessels may cause hæmaturia, but far more frequently this symptom is the result of a subacute inflammatory attack.

The tendency to rupture of minute arteries is also responsible for the large flame-shaped hæmorrhages in the retina, which may occur independently of uræmic convulsions, although they are more commonly found after convulsions.

Hæmorrhage into the tympanic cavities and membrana tympani has been described.

Nervous System.—Reference has already been made to the frequency of unilateral headache and of vertigo. It remains, however, to mention the irritability and weakness exhibited by patients in advanced stages of this disease; they often become low-spirited, and may even attempt suicide. Sometimes, also, after attacks of convulsions, the sense of hearing may be interfered with, and a temporary deafness has been described comparable to the temporary blindness which is far more common. These patients suffer from insomnia which often resists the ordinary hypnotics. Uræmic convulsions may be anticipated when patients with insomnia suffer from persistent headache, and when the amount of urine undergoes much diminution. (See also "Uræmia.")

In renal cirrhosis impairment of muscular strength is relatively frequent, although this is a somewhat late symptom. The skin loses its healthy colour and becomes yellowish, and sometimes slightly jaundiced. This alteration is, however, often due to cirrhosis of the liver. Various forms of skin eruptions have been described in connection with cirrhosis of the kidney; acne rosacea is fairly frequent, and uræmic rashes are met with; there is often a great deal of itching of the skin, and the irritation may give rise to an erythematous rash.

III. The end may be due to insidious inflammation of internal organs. Many patients with contracted kidney, if they do not die from apoplexy or uræmic convulsions, suffer from pneumonia without the usual typical rise of temperature. Pleurisy and simple hydrothorax are frequent, and dry pleurisy is not uncommon.

Renal pericarditis often occurs with very little complaint of pain and with little, if any, alteration of cardiac dulness. Sometimes there is tenderness over the pericardial region, and percussion or the pressure of the stethoscope may be sufficient to cause pain. The physical signs of renal pericarditis change very quickly; sounds heard in the morning may be completely altered in rhythm and character towards the evening.

The transition to the late symptoms of cirrhosis of the kidney is sometimes very abruptly marked, and is usually accompanied by failure in the compensatory work of the heart, failure in the eliminating power of the kidney, and increasing weakness. The pulse frequently loses its high tension, and becomes small, rapid, and irregular. Dropsy may supervene, resembling that of cardiac failure. It is less permanent than that of chronic nephritis, and any improvement of the circulatory powers is almost necessarily attended by diminution of dropsical effusion.

Slight jaundice may supervene, and patients may complain of hæmorrhoids. Diarrhœa is apt to become more prominent and more troublesome, and may be complicated by the appearance of blood from ruptured hæmorrhoids, or from ulceration in the intestine. It is always necessary to watch carefully for spontaneous diarrhœa, since, owing to the frequent use of hydragogue purgatives, this symptom may be overlooked.

As the disease progresses uræmic symptoms become more marked; the headache is more persistent, the dyspnœa more extreme. The end may be hastened by some complication, such as secondary inflammation of the heart or lungs, or it may be reached through uræmic symptoms; on the other hand, a very large proportion die from cerebral hæmorrhage, which is more frequent amongst those who have not suffered from general œdema.

Course and Duration.—For the foregoing account it is obvious that this disease follows an insidious course from the commencement, and it does not appear to add very greatly to the immediate risks of life so long as the circulatory system shows no signs of impairment. I have met with several cases of long duration, more particularly in connection with assurance work, and it appears to me that, so long as the patient can live reasonably and take exercise, the danger may be warded off. With this disease, as with so many others, one is apt to form an exaggerated idea of the seriousness from a consideration of hospital patients. Those in comfortable circumstances undoubtedly live longer than those whose circumstances render care and dietary precautions impossible. The early phases may produce so little discomfort that the patient is unaware of his condition until the urine is examined, as in connection with life assurance. Increased frequency of nocturnal micturition or dyspeptic symptoms may first bring the patient under observation. In other cases the first note of warning may be afforded by impairment of vision, or the disease may remain unrecognised until the breathing power is affected, when it may be difficult to decide whether the albuminuria is the cause or the result of the interference with the circulation. In the large majority of cases the hypertrophied ventricle fails sooner or later, and the patient complains of increased dyspnœa, the amount of urine passed falls below the normal quantity, and dropsy, bronchitis, or pneumonia may supervene. The end may be heralded by attacks of diarrhœa, by vomiting, and by uræmic seizures, or it may occur from cerebral hæmorrhage. It is impossible to forecast the duration of a case of cirrhosis unless the whole of the patient's circumstances are intimately known, but the greatest value attaches to the condition of the cardio-vascular system, the sounds at the apex of the heart affording valuable indications.

General Diagnosis in Nephritis

In some acute cases of Bright's disease, and sometimes in some of the chronic forms, there is but little difficulty with the diagnosis, but cases frequently arise, both in private practice and in connection with assurance work, in which the correct estimation of the significance of albumin may cause considerable trouble and anxiety. Sometimes the circumstances of the case make the appearance of albumin a surprise to the patient and to the medical man, while at others the albuminuria may serve to explain symptoms of an otherwise indefinite type.

When the albuminuria has been detected in the course of an examination for *life assurance*, the proposer may have had no idea that there was anything the matter with him, and it is occasionally extremely difficult to persuade him that there is anything amiss, and that he should take further advice. When it has been found with symptoms of ill-health, the task of the physician is not so difficult, since, as the patient is already troubled about his condition, it is to a certain extent a satisfaction, if even a gloomy one, to have the cause definitely decided. In dealing with the first class of cases, those presenting themselves for life assurance, the diagnosis is often obscure. The physician is practically wholly in the dark as to the proposer's habits, his occupation, and his previous history. It is true that questions upon all these points are asked, and that information is sought from many different sources, but it is almost too much to expect such questions to be answered with the same degree of fulness and accuracy that attends the account given by a patient to a physician from whom he wishes for advice on a question of health. Still, much may be gained by examining the urine at varying intervals, and, if possible, at different hours of the day. My experience with assurance work indicates that there are a great number of cases in which the presence of small traces of albumin has been determined by chemical tests in the total absence of any history pointing specially to kidney disease, and also in the relative absence of symptoms indicative of chronic renal affection. This, I take it, is an important fact, since the tendency of those who consider albuminuria mainly from the point of view of the consulting room is to lay, perhaps, too much stress upon its importance, and to take too gloomy a view of the diagnosis and prognosis.

There are numerous physical signs which are ordinarily described as being associated with chronic albuminuria, such as alterations affecting the pulse and the position of the apex beat of the heart; but these physical signs are wanting in a large majority of cases of albuminuria, such as those met with among young men from eighteen to twenty-five years of age. Perhaps some slight increase of tension may be noted after the albuminuria has been discovered where, in the absence of albuminuria, the pulse might probably have been regarded as normal. Whenever possible, I make it a rule, in cases of slight albuminuria occurring in young men, to get into communication with the medical attendant, and to endeavour to enlist his sympathetic co-operation in clearing up the causation of the albuminuria. The medical attendant can frequently ascertain the relation which the albuminuria bears to varying conditions of diet, of rest, and of work, and he may thus afford very material assistance in proving whether the albuminuria is persistent or intermittent. The questions that naturally arise in any case are whether this drain from the system is constant or occasional, whether it occurs at all hours of the day or only at certain times, or whether it is dependent in any way upon the habits or mode of life of the proposer. Whenever any conflict of opinion arises, it is best to state in detail the tests employed with the results that have been obtained, and to endeavour to get the medical attendant to examine under precisely similar conditions. If it is possible, with the aid of the medical attendant to form a diagnosis, cases of slight albuminuria occurring amongst young men may be dealt with, a small extra premium being charged on account of this abnormality, even though the case must be attributed to one or other of the functional forms of albuminuria.

When dealing with individuals of greater age, it is necessary to be very much more cautious before expressing an opinion that the case is one of functional or intermittent albuminuria, and as the precautions which have to be adopted are practically the same, whether the case is one which is being examined for life assurance, or whether it is a patient who requires advice, it will be advisable to discuss the diagnostic indications more fully, although it is convenient to discuss the importance of each of the diagnostic features separately; but it must be understood that in practice all these diagnostic features must be considered collectively, and due weight assigned to the indications derived from each.

With regard to the persistency of the albuminuria, it is necessary to test the water from day to day, and at different hours of the day, and if albumin is always found to be present, there is a strong presumption in favour of the existence of some form of Bright's disease amongst patients of middle age, though the possibility of a functional albuminuria must be kept in mind when dealing with younger patients. In most cases of functional albuminuria the specific gravity is relatively high. Those which are commonly met with amongst young men, candidates for appointments, or for life assurance, usually have a specific gravity of 1025 or upwards; while on the other hand, where the amount of albumin is the same, there is fair presumptive evidence of chronic renal affection if the specific gravity is low, unless the low specific gravity is found to be an exceptional occurrence. Small traces of albumin may sometimes be due to congestion of the kidney from heart disease, or from some other cause leading to venous engorgement, such as advanced chronic bronchitis or emphysema; sometimes a faint cloud may be found in connection with febrile conditions, such as pneumonia. The albuminuria of heart disease, or of other forms of engorgement, generally varies considerably from day to day, and the urine is mostly scanty, of high colour, and high specific gravity. It is always necessary not only to ascertain that the albumin is permanent, but also that the amount is fairly constant; it must be remembered, however, that in many cases of renal cirrhosis the amount of albumin varies from day to day, and, indeed, that the urine may sometimes be entirely free from albumin. In such patients, however, the pale straw colour is characteristic. while the specific gravity will also furnish material assistance. In broad terms it may be stated that in most cases of transient, temporary, or functional albuminuria the quantity of albumin is relatively small, while the colour and the specific gravity may be normal or above normal. If the albumin is found to be intermittent instead of persistent, no certainty of diagnosis can be founded upon this fact alone, since in some cases of chronic interstitial nephritis the urine that is passed on first rising, before food has been taken, may be found wholly free from albumin. In the same way, as indications of diagnosis, little reliance can be placed upon variations in the appearance of albumin with alterations of external temperature. In many cases of functional albuminuria, it is true that this symptom occurs only with sudden changes of temperature, either with a sudden access of warm weather or with sudden exposure to cold, yet in the early stages of some cases of mild nephritis the same holds good. The influence of cold and damp in increasing the amount of albumin in cases of scarlatinal nephritis has already been referred to. It is occasionally necessary to ascertain whether recumbency in bed has any influence on the presence of albumin in the water. This question has been repeatedly dealt with by Dr. Clement Dukes of Rugby, and he seems to have satisfactorily proved that there is good reason for believing that mere alterations of posture may, by altering the strain upon the capillaries of the Malpighian tufts, cause albuminuria in otherwise healthy individuals. Grainger Stewart held that when albuminuria is found to occur only after meals, or with changes of attitude, or with more or less severe muscular exertion, under mental excitement, or after cold bathing, it may be concluded with certainty that the process is functional. Although this generalisation may hold good for a large number of cases, it must be admitted that numerous other factors require to be considered before adopting such a sanguine view.

In any case of doubt it is always advisable to determine accurately the total quantity of water passed in the twenty-four hours. In cases of functional albuminuria there is mostly no alteration in the quantity, while in those chronic forms of kidney disease which are most likely to cause hesitation in forming a diagnosis, the quantity is usually somewhat greater, or even considerably in excess of the normal amount, and the patient is disturbed by nocturnal micturition. Patients with lardaceous disease mostly pass a large quantity of pale urine; and the amount and the appearance vary according to the stage of the complaint. In the early stages of renal cirrhosis the amount may be but little in excess of the normal quantity, while the colour is almost invariably lighter than usual; in the later stages, when attacks of acute engorgement may occur, the alterations in quantity and in appearance usually leave no doubt about the nature of the case.

It is very rare for febrile albuminuria to cause any difficulty of diagnosis. The existence of high temperature, and the coexistence of scanty, high-coloured water depositing urates, usually afford fair presumptive evidence for considering that the albuminuria is merely symptomatic of the febrile state. This presumption is further strengthened if the amount of albumin appears to bear any relation to the height of fever. Sometimes it increases as the temperature rises, and diminishes with defervescence of the temperature. If after complete defervescence albumin is still found to be present, it may cause further anxiety, unless the case is one of diphtheria, when small traces seem to result from diphtheritic poison, rather than from organic renal changes, or from the febrile state. The microscopic examination of the sediment sometimes affords valuable assistance to the diagnosis; the detection of crystals of oxalates, or of knife-rest crystals of phosphates will often favour a diagnosis of accidental or functional albuminuria; while, on the other hand, the presence of casts requires very careful consideration, since they may be found in cases of functional albuminuria, while they are frequently absent in cases of chronic cirrhosis. Hyaline casts of small size are those which are of least diagnostic importance, while granular and oily casts, especially if fairly numerous and of large size, may indicate chronic nephritis or cirrhosis.

In every case it is necessary to consider associated symptoms and physical signs affecting the circulatory, the respiratory, the digestive, and the nervous systems.

Chronic forms of nephritis and of cirrhosis are, as a rule, attended by changes in the sounds of the heart and in the position of the apex beat. The area of cardiac dulness is generally increased, the apex beat displaced outwards, the extent of displacement frequently bearing distinct relation to the duration of the albuminuria. Both sounds of the heart are modified; the first sound, though it may be somewhat faint and indistinct, is mostly booming, exaggerated, and somewhat prolonged in character. The second sound at the base is accentuated and somewhat reduplicated, but both the sounds and the hypertrophy are essentially indicative of chronic nephritis and of cirrhosis. When met with in connection with lardaceous disease of the kidney, these changes in the position of the apex beat and in the sounds of the heart are indicative of an associated nephritis.

The pulse of chronic nephritis and of renal cirrhosis shows an increase of arterial tension, being wiry or resisting, while the pulse tracing is generally characterised by the breadth of the tidal wave and the distance of the dicrotic notch from the upstroke.

Information of any diagnostic importance is rarely to be obtained from consideration of changes in the respiratory system. If the patient is the subject of chronic bronchitis or of chronic emphysema, very little value may attach to small traces of albumin in the water, especially if these are found to vary with the condition of the lung; but it is sometimes difficult in asthmatic conditions to determine whether the albuminuria exists as a consequence or as a cause. When it occurs as the cause, the urine is mostly of low specific gravity and of a pale colour, and the quantity of albumin is generally small. On the other hand, if the albuminuria is the result of lung engorgement, the urine is more commonly reduced in quantity and its colour is deepened.

In every case of albuminuria the condition of the alimentary system deserves attention. This naturally follows from what has been said of the dietetic forms of albuminuria, and the inability of some patients to take certain articles of diet without the production of albumin in the water. On the other hand, digestive disturbances may arise in connection with chronic kidney disease, either as a sequel to the disease, or as a determining cause of chronic nephritis. The chronic dyspepsia of advanced cirrhosis is well recognised, and is marked by its intractable character, by the occasional tendency to vomiting, and sometimes by sudden and severe diarrhœa.

Valuable assistance may sometimes be gathered from the nature of the skin either in respect of colour or of structure. The anæmia of chronic nephritis contrasts markedly with the reddish-brown tinge which is often seen in renal cirrhosis. The anæmia is often associated with dropsical effusions, and it is by no means unusual to find slight conditions of œdema about the eyelids, and to notice that the features appear larger than usual. The frequency of a watery appearance of the conjunctiva in cases of chronic nephritis must be familiar to every practitioner. On the other hand, the reddish discoloration of renal cirrhosis may depend upon the causation, and will frequently furnish ground for further inquiries. Subcutaneous hæmorrhages may sometimes be found over the lower extremities, but these are comparatively rare except in advanced stages of the disease, in which there is no question of the diagnosis. Thus, also, with the conditions of extreme œdema affecting the lower extremities; these are more frequently to be met with in connection with chronic nephritis than with renal cirrhosis. In some cases of doubt, the appearance of syphilitic eruption or cicatrices, or of syphilitic discolorations of the skin, may indicate the probability of lardaceous disease; the diagnosis of lardaceous disease is, however, more frequently to be founded upon other and more certain signs.

With renal cirrhosis the skin is sometimes abnormally dry, and it may be difficult to provoke diaphoresis. This difficulty, which may arise in the treatment of uræmic symptoms, frequently serves to render the diagnosis of cirrhotic changes more certain. A similar condition is occasionally met with in the slight albuminuria which is so frequently associated with advanced diabetes. The dryness of the skin is then dependent, however, upon the diabetic changes and upon the drain of water from the system.

From the changes in the nervous system many indications may be obtained. Reference has already been made to the persistent headache of chronic nephritis and renal cirrhosis. These headaches are not always very severe, though usually they are of a violent neuralgic type. The headaches of chronic uræmia must be carefully differentiated from those which occur with functional albuminuria, as, for example, with the albuminuria of adolescence. In the latter condition the headache is of a dull nature and associated with intense lassitude and disinclination to work. With functional albuminuria, also, it may be noted that the headache is not so persistent, that it is more marked in the early part of the day, and that it often passes off with exercise or with food. Sometimes in paroxysmal hæmaturia or hæmoglobinuria complaint of lassitude is made, and this occasionally precedes as well as follows the paroxysmal attack.

Renal disease may frequently be first inferred from affections of vision. A gradual development of dimness of vision may lead to an ophthalmoscopic examination and to the recognition of albuminuric retinitis, or of distinct hæmorrhages. Sometimes, however, dimness of vision may occur almost suddenly after a fit, which may be called by the patient a "fainting fit," or a "convulsive seizure," and in such cases it is uncommon to find much evidence of retinal change. When "fainting fits" occur, the possibility of uræmic origin should be considered and the water should be examined. These fits are more prone to ensue in connection with renal cirrhosis than with any other form of renal change, with the exception, perhaps, of acute nephritis, especially when a sequel to scarlet fever. In the latter case, however, the diagnosis has probably been made long before the uræmic seizures have occurred.

Although it is fairly easy, by a consideration of all the surrounding circumstances and by careful and repeated examination of the water, to determine the probable cause of the albuminuria and the probable nature of the renal change, if any, it must be admitted that it is frequently difficult to determine accurately the stage of the disease, more particularly in connection with chronic nephritis. Sometimes intercurrent attacks of hæmaturia may cause an unguarded diagnosis of acute nephritis to be made, and this has necessarily to be altered when the blood disappears, and the urine is found to remain albuminous and pale. It is still more difficult, in cases of chronic nephritis, to decide whether the kidney is in the enlarged condition or whether it has undergone secondary contraction. These refinements, however, are of relatively little importance, compared with the question of determining the extent to which the kidney is still capable of performing eliminative work.

General Prognosis in Nephritis

So long as the kidney retains the power of removing sufficient nitrogenous waste from the system, and so long as it is able to remove sufficient water, the immediate prognosis is fairly good, since whatever the pathological condition, it is evident that some parts of the kidney retain the power of doing good work. It is necessary, however, to consider the amount of the loss of albumin. The amount, in many cases of Bright's disease, notably in cases of renal cirrhosis, is so small that it is almost a negligible quantity,—in fact the drain of albumin is so readily repaired by the consumption of food that the patient appears to suffer very little from this cause. In all probability this is the explanation of the prolonged course of some well-recognised cases of chronic nephritis. The prognosis becomes more grave as the loss of albumin increases. When a large drain of albumin occurs with chronic nephritis, it is always associated with great reduction of weight and loss of strength. Careful attention must be paid to the daily variations in the amount of albumin; it is unwise to form an opinion on the examination of a single specimen; but when the water is repeatedly examined and the percentage of albumin is always found to be very great, the prognosis becomes gloomy.

In the prognosis of Bright's disease it is important to recognise two classes, according to the early or late termination. Thus many patients with acute Bright's disease may have a favourable early prognosis, and a doubtful late prognosis, that is, the immediate prognosis so far as danger is concerned may be favourable, while there may be great danger of the establishment of chronic nephritis, in which case the remote prognosis would necessarily be more hopeless. A very large number of patients with simple acute nephritis recover, provided that the disease is uncomplicated,—in fact the prognosis of acute nephritis depends very largely upon the complications and sequelæ. It is rarely possible, however, to speak very definitely about the prognosis in any particular case, since, in spite of severe symptoms which may occur, the patient may recover. Notwithstanding the dangers of uræmia, of convulsive seizures, of diminution or even suppression of urine, there may be complete recovery; on the other hand, some cases which have apparently been doing well may occasionally take a bad turn and prove rapidly fatal, either from uræmia, or from some secondary inflammatory change affecting the pericardium, pleura, or lung. On the whole, however, apart from accidents of this nature, the prognosis of acute nephritis, although full of anxiety, is comparatively hopeful, but it must be remembered that very many cases starting in an acute attack pass on gradually to chronic nephritis, hence the daily loss of albumin must be watched with anxiety, particularly when the improvement appears to have become stationary.

Puerperal nephritis stands somewhat by itself so far as prognosis is concerned. The prognosis as a rule is generally favourable, and the estimation of danger is to be formed from the severity and the frequency of the eclamptic seizures. There is often marked improvement after delivery, but there is danger from the severity of repeated convulsions. Should the patient recover from the albuminuria of pregnancy there is very little risk of ultimate nephritis, and there is fair ground for believing that when the albuminuria persists after delivery the patient has been previously the subject of chronic nephritis.

Independently of puerperal nephritis, the prognosis, in cases of chronic nephritis, is largely dependent upon the extent to which the drain of albumin interferes with the general health, and also upon the extent to which dropsical changes have progressed. So long as the nutrition of the patient can be kept up, so that the albuminous loss from the kidney is less than the daily gain of albumin from food, these patients may continue in a fair state of vitality for many years. They are, however, subject to dangers from exposure and from secondary complications affecting either the heart or the lung. Frequently, after exposure, the prognosis may suddenly be rendered more grave by a subacute attack of nephritis, which may lead to considerable dropsical effusion of a relatively intractable nature. These patients sometimes incur greater risks through the failure of the circulatory system, which consequently induces a rapid increase of dropsical effusion and of fluid in the pleura or peritoneum. When these effusions have occurred the prognosis necessarily becomes extremely grave, and the time limit is to be estimated by the nature of the pulse, by the quantity and specific gravity of the urine, and by the extent to which breathing is interfered with. There appears to be fair reason, however, for believing that many cases of chronic nephritis may undergo gradual improvement under favourable conditions, and some authors even consider that a cure is possible.

Similar uncertainty attends the prognosis of chronic cirrhosis, of which the danger is to be estimated by the extent to which the different physiological systems are involved. Very frequently cases of cirrhosis, if recognised at an early stage, may be put under favourable conditions with regard to climate, food, and work, and the termination may be almost indefinitely postponed. In forming a prognosis it therefore becomes important to consider the extent to which the circumstances of the individual permit of needful alterations of work or of climate. The prognosis is, however, not so favourable as with chronic nephritis, inasmuch as although it is possible to diminish the risks, it is not possible to cure the disease. In spite of all that can be done, patients with cirrhosis of the kidney pursue a downward course, and, sooner or later, suffer from cardiac failure or from uræmic symptoms. As in chronic nephritis subacute attacks are relatively frequent, and the danger is increased during each attack, since for the time there is great diminution in the eliminative work.

The prognosis of lardaceous disease naturally depends upon the extent to which it is possible to deal with the cause. Many cases have been reported in which, after satisfactory surgical treatment, the loss of albumin became ultimately arrested. It must be remembered, however, that the prognosis depends more upon the primary disease than upon the kidney affection, and that the albumin indicates that lardaceous changes are probably occurring in other organs as well as in the kidney. In these cases there is relatively little danger from interference with the eliminative work of the kidney.

In the same way febrile albuminuria is, in itself, of little importance; it is not likely to produce symptoms due to interference with the work of the kidney, but it is an important indication of the extent to which the febrile condition has modified the nutrition and circulation. With some febrile conditions, as, for example, with diphtheria, copious albuminuria occurs more commonly in severe cases, and the prognosis will be rendered more grave as the albuminuria increases; on the other hand, in many cases of diphtheria small traces of albumin will be found without any additional risk.

The prognosis in any particular case is largely influenced by the nature of the pulse and of the heart's action. It is less serious when the pulse is of good quality and regular than when the pulse is feeble and irregular or intermittent. It is interesting in this connection to note that Sir William Broadbent, a few years ago, drew attention to the prognostic significance of a low blood pressure in acute kidney disease. In acute renal dropsy Sir William Broadbent looks upon the supervention of a certain degree of high tension as an indication of favourable prognosis. He considers that the imperfect development of blood pressure is not to be regarded as the cause of slow recovery or of the complications observed in the course of the disease, but that it reveals the constitutional weakness to which these complications are attributed, and it probably shows that the patient is made of poor stuff. It is further of interest, in connection with these remarks, to recall the frequency with which irregularity of the heart's action and weakness of the pulse form indications of danger in chronic nephritis and renal cirrhosis.

The slighter forms of febrile albuminuria which are met with so commonly in connection with pneumonia, or with typhoid fever, appear in themselves to furnish little or no indication of prognostic value. When albuminuria occurs with advanced forms of heart disease it is indicative of failure of compensation, and the prognosis necessarily depends very little upon the interference with the circulation of the kidney. Frequently the extent to which the treatment has succeeded may be gauged by improvement in the urine; under appropriate measures the albuminuria diminishes in many cases concurrently with the diminution of œdema, and with the reabsorption of effusions from the various serous cavities. When in spite of treatment the albumin continues in fairly large proportion, the aspect becomes extremely grave, since it is evident that the various organs are unable to cope with the calls made upon them.

With regard to the various forms of functional "paroxysmal" or "dietetic" albuminuria, the prognosis is almost invariably good, though some forms of dietetic albuminuria may, if neglected, lead to prolonged irritation of the kidney, and there is little doubt that in some cases renal cirrhosis has been set up by repeated attacks of indigestion. The prognosis is good also in the albuminuria of adolescence.

TREATMENT

Acute Nephritis.—The leading indications during early days are to secure physiological rest for the kidney, to diminish the risks of extension, and to counteract dangers from interference with the eliminative work of the kidney.

As soon as a diagnosis of acute nephritis has been made, the patient should be kept in bed, and the action of the skin promoted by the use of woollen garments, while chill should be avoided by the removal of the sheets. The dietary should, at the commencement, be as non-nitrogenous as possible, and should be limited to the smallest amount consistent with the maintenance of strength. As a general rule patients should be kept to a strict milk diet, and the milk may be given either cold or slightly warmed, in quantities of half a pint at a time. It is advisable to continue the use of milk far into convalescence, since the early use of solid nourishment often entails a return of hæmaturia. If milk produces dyspeptic symptoms skimmed milk may be substituted, but it favours constipation.

Thirst may be allayed by barley water or thin arrowroot, and when the patient is unable to continue milk diet these may be given with beef-tea. Milk, if given in too great bulk, sometimes disagrees. It is advisable to use only small quantities during the first few days, and to increase the amount gradually as toleration is established. Later the patient may take "imperial drink" made as follows:—Two drachms of acid potassium tartrate are placed in a large jug, the juice of one lemon and some sugar or syrup are added, and two pints of boiling water poured in, the ingredients being well mixed. When cool the drink may be placed by the bedside, and taken when desired.

Three dangers must be kept in mind: first, the danger of suppression of urine; second, that of interference with respiration and with circulation; and, third, the more remote danger of the establishment of chronic renal nephritis. The first of these dangers, that of suppression, may be averted by hydragogue purgatives, or by diuretics. Since, however, most diuretics cause an increase in the calibre of the renal vessels, and thus tend to promote engorgement, it is essential to place full reliance upon diaphoretic measures and drugs, and upon hydragogue purgatives.

Salines and mild hydragogues are preferable to mercurials, which often favour diuresis. When dropsy is extreme, headache severe, and when convulsions occur, the use of purgatives becomes imperative. In the milder cases full doses of magnesium sulphate may be employed; but when dealing with cases of greater severity, compound jalap powder is generally followed by good results, although some practitioners prefer to substitute scammony resin, with acid potassium tartrate, in the proportions present in the compound jalap powder. Should convulsions be followed by coma it will be advisable to use croton oil in doses of one-third of a minim and upwards.

When the urine has lost its smoky character, mercurials, such as calomel, may be given occasionally; but when given at night, a saline purge should be administered in the morning to remove the mercury quickly, and to prevent any prolonged irritation of the renal vessels.

Pending the action of purgatives, diaphoresis should be promoted by the wet pack or by the vapour bath. The latter is usually the more prompt in action, but it is necessary to be extremely careful to avoid burns or scalds, since the cutaneous sensibility is so far reduced that severe blistering may occur before there is any complaint of pain.

The wet pack may be used either hot or cold; the latter is generally preferred. In applying the pack, the patient should be completely undressed, or should only wear a thin cotton covering, and wet sheets should be wrapped round him and then quickly covered with successive layers of dry blankets. Care should be taken to leave no portion of the damp sheet projecting beyond the blankets. Copious perspiration usually ensues after twenty minutes or half an hour, and this diaphoresis will often continue after the removal of the pack, if the patient is quickly dried with warm towels and again enveloped in warm blankets. Perspiration may be further favoured during the wet pack by giving draughts of water from time to time.

The first application of the wet pack sometimes fails, and may indeed produce increased headache; while a second application, repeated twelve or twenty-four hours later, is often successful. When diaphoresis is slow, it may be favoured or initiated by small doses of pilocarpine nitrate. This drug is, however, rarely required in acute nephritis.

As the dropsy diminishes and the urine increases in quantity and becomes less smoky, alkaline diuretics may be employed, such as potassium or sodium acetate, or citrate. The late Sir William Roberts recommended that these drugs should be given from the commencement of the attack, and he maintained that, by rendering the urine alkaline it was possible to prevent the coagulation of blood or albumin within the tubules, which, under ordinary conditions, is favoured by the highly acid character of the urine. Alkaline diuretics may be employed with small doses of digitalis, especially if the heart's action is unduly rapid.

Caffeine has been recommended instead of digitalis, and has the advantage of being an efficient diuretic and of causing less digestive disturbance.

Headache, restlessness, and sleeplessness may be relieved by purgatives, diuretics, and diaphoretics, but occasionally the administration of bromides, chloral, or other sedatives is required. Bromides and chloral are extremely serviceable when the pulse is of good quality. Morphine and opium are contraindicated, since they favour dangerous suppression and uræmic symptoms. Hyoscine hydrobromide and hyoscyamine sulphate are free from these dangers, and can be given subcutaneously in doses of $\frac{1}{200}$ grain to $\frac{1}{100}$ grain. The sleep they induce may occasionally be interrupted by dreams, but it is refreshing, and it diminishes the restlessness of the ensuing day.

Persistent vomiting, if it occurs early, may be treated with diluted hydrocyanic acid and preparations of bismuth; but these are comparatively useless when this symptom is due to uræmia, and reliance must then be placed upon diaphoretics and hydragogue purgatives.

During convalescence persistent albuminuria may call for special attention. Persalts of iron have been given with digitalis and strophanthus to diminish the loss of albumin; but iron salts must be used with discretion, since the daily loss is sometimes increased while they are taken. Various astringents have been employed, such as tannic acid and gallic acid, and occasionally I have found some benefit from ergot. Persistent albuminuria is, however, much more amenable to hygienic than to medicinal treatment, and it may often be reduced by a reversion to milk diet, by the avoidance of cold and of muscular and mental strain. During convalescence the greatest watchfulness and care are required, since an early resumption of solid diet may be followed by an increase of albuminuria, and possibly by a return of hæmaturia and dropsy.

Many complications, such as pleurisy, empyema, pneumonia, bronchitis, and congestion of the lungs, are to be treated on general principles, but acute enlargement of the ventricle is an indication for digitalis or strophanthus. Pericarditis necessitates leeches and poultices, but the renal changes contraindicate the internal administration of opium.

During convalescence anæmia calls for the use of mild preparations of iron. The astringent preparations should in general be avoided, since they increase the albumin and may also favour constipation. Œdema of the larynx may require intubation or tracheotomy. It is, however, often associated with œdema of the bronchi and of the lungs, which can only be relieved by measures employed for dropsical affections in other parts.

Scarlatinal Nephritis.—The treatment of scarlatinal nephritis differs but little from that of the foregoing disease. There is reason to believe that the onset is favoured by constipation, and it is therefore desirable, during convalescence from scarlet fever, to administer some mild laxative. The character of the diet, too, has some influence, and with children from three to six years old it is advisable to confine the diet mainly to milk during the time of desquamation, and to keep the patient in bed. The rise of temperature to 101° or 102°, which forms the immediate prelude to scarlatinal nephritis, has been treated beneficially with repeated small doses of tincture of aconite. Very often, however, this initial rise of temperature may escape observation, and the disease, for practical purposes, assumes the form of acute nephritis, in which there is a great tendency to the development of symptoms of uræmia. The treatment of dropsy and of uræmic symptoms does not differ from that already described.

When the immediate urgency of the symptoms has passed away, benefit will often result from the use of perchloride of iron. This must be employed tentatively, and its administration checked if the albuminuria is found to be increased. Quinine is also beneficial during convalescence, and small doses of tincture of digitalis, or of strophanthus, are usually of service when there is much weakness of the pulse.

Chronic Nephritis.—Although it is always desirable to deal with the cause of any diseased process, this is difficult, and often impossible, with chronic nephritis. It is only when it appears dependent upon malaria, syphilis, or continued suppuration that it is possible to attack the cause with any hopefulness. Dietetic precautions are necessary when cases of acute nephritis are tending to a chronic course. Although many forms of routine medicinal treatment have been advocated for chronic nephritis, there is little evidence that they produce beneficial results, and apart from tonic and hygienic measures treatment must be mainly symptomatic.

Diminished urinary secretion, without dropsical effusion, may be treated by giving large quantities of liquid. If milk causes dyspeptic symptoms, imperial drink or home-made lemonade may be given; both are taken more readily if made mildly effervescent. Strophanthus, digitalis, caffeine, or theobromine may do good by increasing the circulation through the kidney. Potassium iodide may be of service, but it is more beneficial when there is dropsical effusion.

Efforts are sometimes made to reduce the amount of albumin eliminated by limiting the albuminous matter given in the diet. It is generally a mistake to interfere thus with the dietary, if the strength and the general health improve during the administration of nitrogenous food. Should hæmaturia occur, the case is to be treated as acute nephritis. The amount of albumin may sometimes be reduced by keeping the patient in bed for a few days. With the same object, astringents, such as lead acetate, iron, ergot, tannic acid, and gallic acid, have been employed, but they may disturb digestion.

Dropsy during the early stages may be influenced by medicinal remedies, similar to those employed in acute nephritis, but later the fluid may require removal by acupuncture, incision, or by Southey's tubes, great care being taken to avoid sepsis.

Uræmic symptoms may develop when there has been long-continued diminution in the daily excretion of urine. Of the two forms, acute and chronic, the latter is most commonly met with in connection with chronic nephritis, and it is, happily, readily affected by diaphoretic and diuretic measures. For persistent headache or sleeplessness nitrites may be used, either by inhalation or by the mouth. Nitroglycerin is perhaps preferable to amyl nitrite, as the effect, though produced more slowly, is more lasting; recently erythrol tetranitrate has been recommended to produce more prolonged reduction of blood-pressure. Sleeplessness may be treated, like that of acute nephritis, with bromides, chloral, or with hyoscine. Morphine has been recommended as a palliative in uræmic symptoms, but the use of morphine or opium in chronic nephritis is usually regarded with anxiety. Vomiting may cause considerable weakness, and has often to be met by nutrient enemata. Urgent diarrhœa is occasionally controlled by enemata containing opium, but astringents are rarely attended by success. When dyspnœa is associated with heart weakness it may be treated with cardiac stimulants, while, when associated with much lung engorgement, expectorant measures give better results. When the dyspnœa appears to be of uræmic origin, purgatives, diaphoretics, and diuretics should be employed.

In the early stages, before the illness is sufficient to interfere wholly with the ordinary occupation, benefit may result from rearrangement of habits and work. While it is distinctly undesirable to continue any occupation involving physical strain, worry, or mental excitement, it is inexpedient to insist upon complete separation from work.

Subacute attacks with hæmaturia may be averted by the use of woollen garments and of a broad flannel belt over the loins. When circumstances permit, patients with chronic nephritis should be sent to a warm climate during the winter months. Torquay, Ventnor, or Bournemouth may be recommended, but greater advantages may be derived from a winter spent in Egypt or Algeria.

Renal Cirrhosis.—The treatment of renal cirrhosis to some extent resembles that of chronic nephritis, but this resemblance is mainly characteristic of the later stages of the disease, the earlier conditions frequently necessitating special forms of treatment. It is very rarely possible to deal directly with the cause of the disease, though when due to gout, to lead-poisoning, or to syphilis, these various conditions should be treated on general principles. Usually, however, the recognition of cirrhosis of the kidney is only made when the disease has probably been in existence for a lengthened period, and the treatment must accordingly be mainly symptomatic.

Since the risks of cirrhosis of the kidney are undoubtedly influenced by external conditions, it has been recommended that ordinary occupations should be entirely given up. If, however, the daily routine is fairly free from anxiety and worry, and the symptoms are not severe, it is better for the occupation to be continued. Residence during the winter months in warm or temperate climates is advisable, and warm clothing, especially flannel or woollen garments, should be worn.

To control the cirrhotic changes within the kidney, potassium iodide is often advocated, and the double chloride of gold and sodium has been used in the United States in doses of from $\frac{1}{30}$ grain to $\frac{1}{10}$ grain once or twice a day. Although complaint may be made of the increase in the amount of urine, it is not advisable to attempt to diminish the polyuria, though belladonna may be used to control the frequency of nocturnal micturition. The diet requires careful regulation, since the appetite is commonly poor and capricious, and dyspeptic symptoms are frequent. When severe dyspepsia and vomiting occur late, they are to be regarded as of uræmic origin and dealt with accordingly. (See treatment of Chronic Nephritis.) In the earlier stages vomiting may be treated with tincture of iodine, silver nitrate, creosote, or carbolic acid.

Severe diarrhœa, when it occurs late, may necessitate the employment of enemata of starch and opium and the use of milk diet, but unless very exhausting, it is better not to attempt to check diarrhœa too suddenly.

Persistent headache and insomnia, which are more frequent in renal cirrhosis than in chronic nephritis, are similarly to be dealt with by vaso-dilators; occasionally, however, the sleeplessness requires a hypnotic; bromides, chloral, sulphonal, paraldehyde, and hyoscine are better than opium or morphine. Circulatory failure, and low tension of the pulse, may be improved by the use of alcohol, but digitalis, strophanthus, or caffeine citrate is often required. Spasmodic dyspnœa is usually benefited by cardiac tonics, though sometimes nitrites may also be of service.

Appropriate measures must be adopted when the dyspnœa depends upon œdema of the lung, or upon an accumulation of fluid within the pleural cavity. If during uræmic dyspnœa the urine is much below the normal standard, relief may follow the use of diuretin.

Indications of pulmonary engorgement, bronchitis, and pericarditis with renal cirrhosis are to be treated on general principles.

In view of the comparative frequency of cerebral hæmorrhage during renal cirrhosis, recurrent migraine or neuralgic headache is often regarded as an indication of danger. For the relief of this symptom nitrites or nitroglycerin may occasionally be beneficial, but antipyrin and antifebrin are often used in moderate doses. Should cerebral hæmorrhage occur, the case must be dealt with on ordinary principles, but the prognosis is rendered much more serious by the coexistence of renal changes. Epistaxis may be checked by rest, by ice, by tannic or gallic acid, or by plugging the nares.

Impairment of muscular strength may call for tonic remedies, and for modifications of occupations which involve much muscular strain. The loss of power is most marked towards the end of the disease; during the earlier stages it may be counteracted by moderate exercise and by gentle gymnastics.

During uræmic convulsions very little can be done; nitrites and amyl nitrite have been recommended, but are not of much service, and do not shorten the subsequent coma. When convulsive attacks succeed each other with great rapidity, chloroform may be administered; the hypodermic injection of morphine has also been recommended. It is perhaps better to use hydragogue purgatives, and croton oil, on account of the smallness of the dose, is usually selected.

The dropsy, which usually complicates the closing scenes of renal cirrhosis, must often be regarded as of cardiac origin, and it necessitates cardiac stimulants and diuretics rather than hydragogue purgatives.

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Nerves, Peripheral.[1]

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General Considerations.—A peripheral nerve consists of a delicate scaffolding of connective tissue enclosing the essential nervous structures. The scaffolding presents an external perineurium, which surrounds the entire nerve, an epineurium which divides it into fasciculi, and a very delicate endoneurium which runs between the nerve fibres of each fasciculus. These structures are of the usual type of white connective tissue; they are strong, elastic, and resistant both to injury and to the spread of pathological processes; they enclose not only the nerve fibrils, but also small blood- and lymph-vessels, and probably nervi nervorum.

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[1] The following article being the work of two writers, its various sections are indicated in the syllabus by the initials (T.) and (W.), which imply respectively the responsibility of Mr. Thorburn and of Dr. Williamson.

The nerve fibrils are mainly of the medullated type, and they run in parallel series without breach of continuity between their terminal connections, which consist of a central ganglionic structure at one end, and a muscle plate, tactile corpuscle, or secreting organ at the other. The typical medullated fibre presents three constituents, viz. (1) The axis cylinder, which is absolutely continuous throughout its length; (2) The neurilemma, primitive sheath or sheath of Schwann, which forms a delicate external tube; (3) The myelin, which lies between the axis cylinder and the enclosing primitive sheath. At the "nodes of Ranvier" the primitive sheath presents constrictions situated at fairly regular intervals, and in the area between each pair of adjacent nodes there is found a nucleus which lies in the myelin and in close apposition to the primitive sheath; more accurate observation shows that at each node of Ranvier the primitive sheath has an actual interruption in its continuity.

It thus appears that the axis cylinder passes continuously through a number of minute tubes serially arranged. Each tube may be regarded as a cell, of which the wall forms the sheath of Schwann, and the body the myelin, while the nucleus presents but slight departure from ordinary types. The axis cylinder, on the other hand, is merely an enormously long process of a single cell or neuron, and its nucleus lies in a central nervous organ; it is thus devoid of all inherent capacity of growth or repair, and is dependent for its nutrition on its central connections; this dependence upon a distant base renders it peculiarly susceptible to the severance of its communications, but has the compensatory advantage that the base itself is not liable to be injured at the same time as the axis cylinder. The axis cylinder alone is the conducting nerve structure; the primitive sheath and myelin are independent insulating cells, and are entirely absent from "non-medullated fibres." Again, the axis cylinder presents a peculiar relationship to its insulating cells, which may be compared to the influence of the blood upon the blood-vessels; the cylinder merely passes through its enclosing cells, but its health is essential to the health of those cells, and *vice versa.* The development of the axis cylinder also probably differs from that of its containing media; the axis cylinder is thrust out into the periphery from the central (epiblastic) nerve cell: the myelin and primitive sheath are more probably of mesoblastic origin. The importance and interest of these facts will be more apparent in connection with the pathology of injuries to nerves.

INJURIES OF NERVES.

Nerves are liable to complete division by cuts and tears, to partial section, to punctured wounds, to contusions and to compression by inflammatory products and the like. So long as they are not directly attacked they present a high degree of resistance to surrounding conditions; thus the sciatic nerve has been laid bare in its entire length without physiological injury, and nerves are constantly found to pass through inflamed and even purulent areas without suffering; this independence of their surroundings depends mainly upon the facts that they carry with them their own blood-vessels, and that the nutrition of the axis cylinders is governed by the distant nuclei of the neurones.

Complete section is a common result of accidental cuts and stabs, of gunshot wounds, of certain surgical operations, and especially of amputations; as a result of accident it is most common in the region of the wrist, the ulnar, median, or radial nerve being divided by such agents as chisels, knives, and especially broken pieces of glass. Immediately after section the cut ends of the nerve may occupy one of four possible inter-relationships, viz. (1) Contact or close apposition; (2) Separation by a distinct interval; (3) Separation complicated by intervention of some other structure, or of a foreign body; (4) Complete loss of the peripheral end, as in amputations. The pathological results will differ somewhat in each of these cases.

Division without separation of the cut ends is rare, as the elasticity of the nerve causes it to retract when cut; practically it is met with only in the case of the smaller nerves, in partial section, and after the operation of primary suture. The changes which arise under such conditions fall into three classes, viz. inflammatory reaction of the connective tissue stroma, degeneration of the nerve fibres, and subsequent regeneration of the latter. The connective tissue changes present no peculiarities; they cause swelling of the cut ends, with the production of two "end-bulbs," which unite into a fusiform mass of "nerve callus"; this nerve callus re-establishes the mechanical continuity of the nerve, and forms a cicatrix which is eventually absorbed. As regards the behaviour of the nerve fibres there is still much controversy, and it will be convenient to describe first the view which appears to be most generally adopted, and to point out later certain difficulties which lie in the way of its acceptance.

Section of a nerve is quickly followed by *degenerative changes* in its fibres, which involve the entire peripheral segment down to the terminations, and include the muscle plates; in the central segment the degeneration extends only to the first or second node of Ranvier above the lesion. This degeneration is first seen in the myelin, which becomes turbid and granular, and after a few days breaks up into large drops; in the ensuing weeks these drops yield a fatty detritus, which is carried away by the lymphatics and leucocytes. A few days after the injury the axis cylinder also loses its distinctness of outline, and becomes swollen and granular, finally breaking up into detritus. Destruction of the sheath of Schwann and of its nuclei has not been proved to occur, but these structures become difficult to distinguish after the loss of the myelin and axis cylinder. These degenerative changes are generally complete in about two months, and they appear to proceed simultaneously in all parts of the peripheral segment; in the cut end of the proximal segment they are more quickly carried out, and they only extend upwards for about one millimetre.

Degeneration is accompanied and followed by *regeneration*, which occurs only at the cut end of the central segment, and which commences at the nodes of Ranvier immediately above the level of degeneration. A few days after section the axis cylinders of this region swell, become more distinctly fibrillated, and commence to grow down into the nerve callus; there is thus formed a leash of new fibrils, which penetrate the callus, reach the degenerated peripheral end, and then continue to grow down into it until they eventually attain to the muscles and skin. As these new prolongations of the old axis cylinders pass onwards they acquire a fresh covering of myelin and primitive sheath, but how they do so is not clearly proved. Probably the majority run along the old channels of the neurilemma, find there the undestroyed nuclei of the degenerated peripheral end, and stimulate them to reform myelin; others go astray either in the epineurim or in the general cicatrix, are thus lost, and never acquire any functional value; in the latter case their medullary sheath is presumably derived from proliferation of the nuclei of the central end. In association with the above processes the cells of the spinal cord and ganglia present various minute changes, which are the anatomical indication of their reparative activity, but which hardly call for description in this place. Finally, the process of regeneration is extremely slow, as might be anticipated from the distance to be traversed by the outgrowing axis cylinders; in the case of small nerves (*e.g.* digital branches) it may take many weeks, and in larger trunks it occupies months or years.

Summarising the above, we may say that:—(1) Mechanical continuity is restored in about a fortnight by a connective tissue cicatrix, which possesses no nervous functions. (2) The nerve structures proper or axis cylinders die in the immediate neighbourhood of the wound, and in the whole of that segment which is cut off from the ganglionic nuclei. (3) The accessory or insulating cells degenerate *pari passu* with the axis cylinders. (4) Regeneration of the axis cylinders is effected solely by the central portions, which retain connection with their nuclei. (5) Such regeneration is extravagant, and produces an excessive number of new nerve fibrils. (6) Of the latter many get lost in the cicatrix. (7) Others grow down into the peripheral tract. (8) In so doing they acquire fresh insulating elements, either by proliferation from the healthy central end, or by re-excitation of quiescent nuclei in the degenerated peripheral cord.

The above history of events is founded largely upon the original observations of Ranvier, which have in the main been confirmed by subsequent researches, but there is still considerable difference of opinion regarding the details of the process. In the first place, it is stated that "primary union" may occasionally occur with such rapidity that the above complicated series of events could not have been carried out. In man there is no anatomical basis for this view, but in the lower animals, and especially in birds, regeneration has apparently been shown to occur with enormous rapidity. To the clinical evidence of primary union in man we shall again refer; broadly, we may say that it is hardly sufficient to establish the doctrine of immediate restoration of the continuity of the axis cylinders or primary union.

A further important divergence from the views expressed above is that generally associated in this country with the researches of Bowlby, who denies that regeneration occurs solely from the proximal end of the nerve, and holds that new axis cylinders are formed by the nuclei of both central and distal ends. This view is based largely upon the appearance of healthy nerve fibres in the peripheral end of an interrupted trunk, but such appearances are capable of at least two other explanations, viz. (1) Regenerated or down-growing fibres may escape from the central end-bulb of a cut nerve, and attain to its peripheral end by an indirect course even when there is no apparent restoration of mechanical continuity. (2) Collateral nerves may grow into the peripheral end as they grow into transplanted flaps and other structures.

We have thus far considered only the pathological results of nerve section in cases in which the cut ends are in approximate contact. When they are not in such contact, as when they are separated by distance or by intervening substances, the results are less open to dispute. The peripheral portions now undergo progressive degeneration, and become converted into mere fibrous cords, which gradually atrophy, but which remain as distinct structures for an indefinite period; the cut end of this cord is generally thin and tapering, or it may occasionally present a slight bulb. At the cut surface of the proximal portion of the fibre, on the other hand, we have active changes: the connective tissue becomes inflamed, and forms an oval bulb or swelling; in a few days the axis cylinders commence to grow into this swelling and to ramify throughout the cicatrix, acquiring a covering of myelin and primitive sheath. Hence there results a large end-bulb, more or less closely adherent to the general wound scar, and consisting of newly-formed nerve tissue chaotically arranged in a fibrous cicatrix; the attempt at repair has proved abortive from the want of a channel of direction. After a very long period the central ends undergo gradual atrophy, and all of these conditions are accompanied with atrophic changes in the correlated areas of the central nervous system. Lastly, in the case of amputations the nerves of the stump behave similarly to the central ends of divided nerves, the end-bulbs when much enlarged—as they are apt to be in septic cases—forming the so-called "amputation neuromata."

Tearing of important nerves is not very common, except in the case of the brachial plexus (*q.v.*), and of traumatic avulsion of limbs. The results produced are similar to those of complete section with separation of the divided ends.

Partial section and *punctured wounds* of nerves are most commonly met with in the region of the wrist. The results are similar to those of complete section with apposition of the cut surfaces, but do not involve the whole of the functions of the damaged trunk. Punctured wounds appear to be peculiarly liable to the development of a continued neuritis.

Contusions of nerves result from various injuries of civil life, and are also commonly produced by bullet wounds, which thrust aside nerve trunks without readily perforating them. Severe contusions cause much hæmorrhage into the trunks, with disorganisation of the nerve fibres, and thus produce results similar to those of section with separation of the ends; but every grade of injury is met with from this, the most severe form, to the mere tingling which results from rolling beneath the finger such exposed trunks as the ulnar or the lingual.

THE SYMPTOMS of injuries of nerves are similar in all the above cases, and may be considered collectively. They are variously combined in accordance with the physiological functions of the affected trunk.

Paralysis of the atrophic type is developed immediately, and is accompanied by wasting and fatty degeneration of the affected muscles, which attains its height in about three or four months after the injury. The affected muscles usually cease to react to the faradic current within three or four days, and they then quickly present the galvanic reaction of degeneration. After a few weeks all electrical contractility is lost. Should recovery ensue, voluntary contractility often precedes the capacity for electrical stimulation.

Sensation of all kinds is abolished, but is often partially restored by the agency of collateral branches. The margins of anæsthesia are thus rarely quite sharply defined. Pain and hyperæsthesia are common in cases of partial injury. Pain in the cicatrix of a cut nerve is common, and is often referred subjectively to the terminal distribution of the divided trunk. During recovery the sense of touch usually returns before those of pain and temperature, whilst it is a general rule that in cases in which the functions of the nerve are not totally abolished sensation is less injured than is motor power.

Vaso-motor changes are manifested by alterations in temperature and in colour. The temperature changes are somewhat variable, but in the majority of cases there is for a few days a rise of two or three degrees, followed later by a fall which may amount to eight or ten degrees (F.), and which may last indefinitely. Redness and pallor correspond respectively to rise and fall in temperature. There is also a marked tendency to sudden variations in the vascularity of the affected parts under the influence of slight external causes, and thus even light rubbing of the anæsthetic areas may cause marked suffusion with blood. The various changes met with appear to be most readily explicable on the theory that the arteries have a local vaso-motor mechanism which when cut off from the spinal cord at first acts imperfectly and allows of dilatation; that after a few days this mechanism acts with excess of energy and produces local anæmia, but that such local control is unstable and is liable to give way under the influence of slight irritations and to again permit of dilatation of the arteries (cf. art. "Inflammation," "Hyperæmia.")

Secretory phenomena are met with in the skin and in special glands such as those of the mouth and eye. The skin may be abnormally dry or moist, and the perspiration is not rarely of a peculiarly fœtid odour.

The so-called *trophic changes* involve mainly the skin and its appendages, the synovial membranes, and the muscles. The skin is generally peculiarly smooth, "glossy," thin, and delicate. Its papillæ are small and its epithelium atrophic. The hair becomes harsh and dry, and is readily shed. The nails are brittle, and tend to transverse or vertical cracking, or they may be coarse and thick with swelling of the matrix. The subcutaneous tissues are thin and atrophic. Eruptions of herpetic or eczematous type are common, and may be recurrent. Obstinate ulcerations, whitlows, small sloughings, and occasionally more extensive gangrene, are met with. Arthropathies generally appear as acute swellings, with or without pain and redness. In this stage the condition is one of synovial effusion, and resembles in appearance an acute rheumatic affection. Rarely proceeding to suppuration, the effusion generally reaches its height in a few days, and then subsides slowly, leaving considerable thickening of the joint capsule and a great tendency to the formation of periarticular and intra-articular cicatrices. Serious deformities and ankyloses are apt to be thus produced, especially in the fingers. Less commonly than the joints, the sheaths of tendons may present similar changes. Atrophic changes in the bones are occasionally described, but rarely attain to any clinical importance.

Trophic changes of the skin are generally met with in anæsthetic regions, or less commonly in association with hyperæsthesia. They are limited to the cutaneous distribution of the affected nerve. They are, as a rule, somewhat late phenomena, and they follow all forms of nerve injury. The deeper trophic lesions, on the other hand, concern the paralysed muscles with their adjacent joints, are usually of early appearance, and are seldom met with except in complete nerve section.

The PROGRESS of a case of nerve injury will depend mainly upon the facility with which the nerve can be regenerated, and hence upon pathological peculiarities which have already been referred to. Should there be no regeneration—as in cases of wide separation, extensive contusion, or interposition of other structures between the cut ends—no recovery is possible, and such slight improvement as may gradually occur is due solely to the vicarious action of adjacent muscles and nerves. On the other hand, regeneration or restoration of physiological continuity is followed by the gradual restoration of sensation and motor power, although it is doubtful whether such recovery is ever quite complete in the case of large trunks. The time required for recovery is very great, and may extend to months or years. It is longer in the case of the larger trunks, and is shorter in the young than in later life. It is interesting to note in this connection that although it is inconceivable that all the repaired axis cylinders should grow down into the tracts with which they were previously connected, there is little or no confusion in the passage of spinal impulses to the muscles. Confusion of sensory localisation is, however, not uncommon, and frequently of long duration.

TREATMENT.—The regeneration of nerves and restoration of their functions is materially aided by such measures as the use of local warmth, massage, and electrical stimulation of paralysed muscles, protection from irritations which evoke trophic changes, prevention of malpositions which may lead to deformities, and guarding against ankylosis of inflamed joints. All such measures must, however, be regarded as subsidiary, and in all practicable cases suture of a divided nerve should be undertaken as a primary or secondary operation. Primary suture is performed at the time of injury; secondary suture is practised at a later date, and should only be undertaken after the original wound has healed, or in cases of severe contusion which have proved incapable of spontaneous recovery. As aseptic healing is essential to the success of these operations, they should never be attempted in an inflamed or suppurating wound.

Primary suture is usually readily effected through a traumatic wound which may, if necessary, be extended along the divided nerves. The cut ends are exposed, bleeding is arrested, and sutures are then applied so as to bring the nerve ends into contact, a proceeding which is seldom difficult if aided by flexion of joints or other suitable fixation of the limb. The cut ends should be interfered with as little as possible, but if bruised they may be freshened by a sharp cut with the scissors; the sutures should be of chromicised catgut or kangaroo tendon, and as few and delicate as is consistent with security: they are passed directly through the nerve fibres, most easily by means of curved needles with round points, and they should be tied only sufficiently tightly to produce apposition; for all ordinary purposes, such as suture of the median, radial, and ulnar nerves, two such sutures passed about an eighth of an inch above and below the cut surfaces will suffice. If there be much tension an extra tension suture may be passed some distance beyond the cut ends, and in the case of large trunks "para-neural" sutures may be passed through the sheath. Unabsorbable materials should never be used for these purposes, as they may produce extremely painful scars.

The results of primary suture are usually good, although recovery is often very slow, and is at first disappointing to the patient and possibly to the surgeon; it is rare to find any evidence of restored function in less than two months after the operation. In certain cases it is stated that such suture is immediately followed by return of previously abolished functions, and it is claimed that we have here a "primary union" of the divided axis cylinders without the complicated process of degeneration and regeneration above described. In the lower animals, and especially in birds, such a condition appears to be by no means very uncommon, but in man the evidence in favour of its occurrence is less satisfactory. The observations are based largely upon the return of sensation, which is open to the objection that it involves a subjective element on the part of the patient. Further, it is found that sensation thus rapidly restored is apt to prove evanescent, and it is suggested that its presence is due to a hyperexcitability produced in the over-lapping fibres of adjacent nerves. The difficult question of *perception* of sensation has also to be considered, and is best illustrated by the two following cases recently observed by the writer:—

1. A boy had division of the median nerve of many months' duration, was found by my house surgeon to be completely anæsthetic, and was sent to the operating theatre; there testing him, I found beyond all question both sensation and fair localisation in the affected area; no operation was performed; two days later I found the same regions absolutely anæsthetic.

2. A man with fractured spine, crush of the cauda equina, and complete anæsthesia in the distribution of the second sacral roots on both sides, of eight weeks' duration; laminectomy; on following day distinct sensation in affected cutaneous area; two days later anæsthesia was as before, and so remained until the case was lost sight of.

There appears to be only one possible explanation of such cases, viz. that collateral branches enter the affected area, but that their stimulation is insufficient to evoke *perception*, unless the cerebral centres be rendered abnormally excitable by the mental stimulus of an impending or recent operation. And, again, the immediate but evanescent return of sensation after primary suture is explicable by the view that before degeneration has occurred, the peripheral segment of the nerve may for a time convey an impulse or current up to the cut, and may there *induce* a second current in the central end by a mechanism similar to the paradoxical muscular contraction of the physiologists. On these and other grounds the primary union of divided nerves can hardly be regarded as proved to occur in man, although a few remarkable cases show beyond doubt that nerves of the size of the radial and ulnar may occasionally regain their functions within a few days after section.

Secondary suture is a more complicated procedure than is the primary operation. The limb being cleansed, a free incision is made over the course of the nerve, and the cut ends are sought for, a process often rendered very difficult by extensive cicatrisation and by the atrophy of the distal end. The use of Esmarch's bandage facilitates the discovery of the nerve, but as a rule the writer prefers to avoid it, as it tends to increase the extravasation of blood after closure of the wound; if the incision be long the ends of the nerve will generally be found in their anatomical relations at some distance from the scar, and their separation for a distance assists their subsequent adaptation. When the general cicatrix has been thoroughly cleared, the nerve ends are picked up lightly by their extreme tips and freshened with scissors, after which they are united as in primary suture; it is to be remembered that one central end may have two or more distal divisions; also that the central end is large and bulbous, and contains the essential axis cylinders, while the distal ends are generally thin, and contain no vital nerve elements. The greater part of the central bulb must be cut away to expose fully the axis cylinders, but the more passive distal end should be spared as far as possible.

Prognosis after secondary suture is said to be even better than after the primary operation, but the time required for regeneration is often enormously long, sensation seldom returning in less than three or four months, while motion is usually deferred for twice that length of time. How long after the injury the operation holds out any prospects of success cannot be stated, but as good results have been obtained after eighteen years, no case need be rejected on account of its duration. After secondary suture cases of rapid and almost immediate recovery are also recorded, but much of the evidence is open to question.

Plastic operations are occasionally adopted in cases in which wide separation renders impossible the adaptation of cut nerves, but such operations are by no means highly successful. Phillipeau and Vulpian experimentally grafted a fragment of the lingual nerve into a gap in the hyperglossal; Gluck obtained recovery after grafting a rabbit's sciatic upon the fowl; two cut ends of the median have been attached to the intact ulnar with good effect; Tillmanns ingeniously turned down a flap from each of the two cut ends of the divided ulnar and median nerves, and thus obtained a continuous strand of nervous tissue. In all such cases the results appear to depend upon the provision of a guide for the down-growing axis cylinders of the central end, and thus recovery has been obtained by slipping the severed ends into a decalcified bone tube, or by uniting them by strands of catgut (Vanlair). Finally, on a different principle, the long bone of a limb has been shortened by resection in order to allow of approximation of the ends of divided nerve trunks.

Traumatic neuritis is a not very common condition which may result from injuries of nerve trunks. In the majority of cases the primary injury has been comparatively slight, and consists of a contusion, puncture, or partial section, while the sufferer is generally the subject of gout, rheumatism, syphilis, lead-poisoning, or other similar constitutional condition. Of the pathology little is known from direct observation, but the disease appears to take the form of an acute, or, more commonly, of a chronic inflammation of the stroma of the nerve, which tends to ascend its trunk, and to cause irritation of and pressure upon its fibres.

The disease generally manifests itself some weeks or months after a slight injury in the form of gradually increasing hyperæsthesia and neuralgic pain which involve the affected trunk and spread gradually to its higher branches. Motor weakness and sometimes spasmodic phenomena supervene, and vaso-motor and trophic symptoms are common, but complete anæsthesia and paralysis rarely develop, the prominent symptoms being constant wearing pain and crippling by trophic changes and deformities. In the majority of cases the hand is the selected region, and not a few examples closely resemble Raynaud's disease except in the fact that they have no tendency to a symmetrical type. Occasionally the inflammatory process appears to extend to the spinal cord, and epilepsy is said to supervene in some cases. It can, however, hardly be doubted that the cases described as traumatic neuritis include various ill-defined nervous troubles such as painful cicatrices, hysteria, and possibly reflex affections of various kinds.

The treatment consists generally in the treatment of neuralgia, the most useful application being belladonna applied along the course of the affected trunk. In cases of great pain localised in a cicatrix, the latter should be freely excised, while extreme examples may call for nerve stretching or for the amputation of digits. Again, many cases are curable by freeing the affected nerve from the general wound cicatrix, especially if the latter be attached to movable tendons, as is common at the wrist. In some a removable source of irritation will be found in the form of a small foreign body.

Pressure lesions of nerves result from the most varied conditions, of which the most prominent are tumours, aneurysms, cicatrices, fragments of broken bones, callus, dislocated bones, the fœtal head, and external substances, such as crutches, splints, ligatures, and bandages. In many of these cases the results of pressure are most conveniently regarded as symptoms or complications of the primary disease, but in certain instances they become so prominent and characteristic as to call for special description. The resultant symptoms are in severe cases similar to those of nerve section, and are paralytic in their nature, pain and hyperæsthesia being mainly conspicuous by their absence. The onset is generally sudden, especially in the more characteristic examples, in which the source of pressure is a displaced bone or a hard substance compressing a nerve against a bone. Paralysis is generally much more marked than anæsthesia, and trophic changes are comparatively rare. The intensity and duration of symptoms will naturally depend essentially upon that of the compressing agent.

Of these cases the common pressure lesions of the musculo-spiral nerve afford the most typical example. Masses of callus and fractured or dislocated bones are especially liable to involve the nerves of the upper limb, and again the musculo-spiral nerve is prone to suffer in injuries of the humerus, while the brachial plexus is affected by fractures of the clavicle and dislocations of the shoulder. In all such cases the essential treatment consists in the removal of the compressing agent, followed by the use of such subsidiary agents as have been recommended for nerve section. When the pressure is due to fragments of fractured bones it is commonly advised to obtain bony union before dealing with the nerve injury, but under modern conditions the writer certainly prefers early operation.

Dislocation of nerves is extremely rare, except in the case of the ulnar, which is apt to be slipped forwards from its groove behind the internal condyle of the humerus. The latter injury is generally the result of a direct blow, although occasionally assigned to an abnormally small size of the condyle; a few cases are apparently congenital. The affected trunk slips forward on to the inner aspect of the condyle, where it can be readily felt; it may either retain this position, or it may slip in and out of its normal bed with the movements of the arm. The characteristic symptoms are pain and tingling along the course of the ulnar nerve, exaggerated by movements or pressure, and sometimes associated with an ascending neuralgia or neuritis. The displaced trunk is usually readily reduced, but extremely difficult to retain in position. Recent cases may be treated by fixation of the arm in an extended position with adaptation of a pad, not over the nerve, but over the condyle. Old-standing examples may cease to give trouble, the nerve becoming inured to its vicissitudes, or, if symptoms continue, cure is effected by opening the groove behind the condyle, replacing the nerve, and binding it down by suturing the deep fascia over it.

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NEURITIS

Neuritis, or mono-neuritis, is the term applied to inflammation of a nerve.

[When many nerves are affected the condition is termed multiple peripheral neuritis, or polyneuritis. It is usually bilateral and symmetrical, and it will be considered subsequently.]

Causes of Neuritis (*Mono-neuritis*).—The affection is frequently produced by injury of the nerve through wounds, contusions, compression, adjacent bone fractures, or through dislocations. By prolonged violent muscular exertion neuritis may be produced in a nerve surrounded by the contracting muscle fibres. Adjacent inflammatory processes in bone or other tissues may cause neuritis by spreading to the nerve. Other causes are cold, rheumatism, gout, and diabetes, and the infiltration of a nerve by new tissue in syphilis or cancer. A mono-neuritis occasionally, though very rarely, follows typhoid fever, small-pox, diphtheria, tuberculosis.

Neuritis of a single nerve usually begins in the outer sheath, this condition being known as perineuritis. Sometimes the neuritis involves chiefly the interstitial connective tissue of the nerve—interstitial neuritis. In other cases the nerve fibres themselves are chiefly affected—parenchymatous or degenerative neuritis.

Pathological Anatomy.—In perineuritis the connective tissue around the nerve is red and swollen; the small vessels of the sheaths are dilated and full of blood; occasionally there are small hæmorrhages. The hyperæmia is followed by serous transudation and extravasation of leucocytes between the sheath and the nerve bundles. At the seat of the changes a local spindle-form swelling develops. When the condition is more advanced round cells infiltrate the septa of the nerve, and may penetrate between the nerve fibres, causing an interstitial neuritis, and finally the nerve fibres degenerate. A localised proliferation of connective tissue may cause nodular swellings at one or more points, producing a nodular disseminated neuritis.

In interstitial neuritis, cell infiltration and changes similar to those mentioned affect the connective tissue between the nerve fibres, which generally degenerate secondarily.

In parenchymatous or degenerative neuritis the nerve fibres break down and present changes similar to those of Wallerian degeneration, after division of a nerve. The parenchymatous neuritis may develop primarily, or it may be secondary to an interstitial or peri-neuritis.

(Periaxial segmentary neuritis is described under lead neuritis.)

Localised neuritis of a nerve is followed by secondary degeneration down to the peripheral part of the nerve fibres; whilst the central portion of the nerve, *i.e.* between the local neuritis and the cord, usually remains unaffected.

Symptoms.—Slight constitutional disturbances may be present, but the chief symptoms are local. The most important is pain, localised in the nerve or its area of distribution, but sometimes affecting the whole limb. The pain is boring or burning in character, rarely darting, it is increased by movement; it may be absent when the nerve is chiefly motor. A superficially situated nerve may be felt to be swollen, and is very sensitive to pressure. Rarely there is slight redness of the skin and slight œdema superficial to the nerve.

In the distribution of the nerve there is first paræsthesia and hyperæsthesia—later anæsthesia and paralysis and atrophy of muscles supplied. Rare skin affections are glossy skin and herpes zoster. The electrical excitability is increased, then diminished, and finally a reaction of degeneration may be obtained. In the interstitial neuritis the development is very chronic; pain and tenderness of the nerve are less marked.

In the parenchymatous neuritis swelling of the nerve cannot be detected. The nerve is much less painful on pressure. The other sensory and motor symptoms are much the same.

Diagnosis.—The important indications are the pain and tenderness of a nerve, and the localisation of the symptoms to its distribution. In neuralgia the pain is more intermittent than in neuritis, and there are not the loss of sensation and muscular paresis in the distribution of the nerve (see section on Neuralgia).

Treatment.—Removal of the cause, if possible, is the most important point. Treatment for gout, diabetes, or syphilis may be indicated. Perfect rest of the affected part is necessary. Sir Wm. Gowers thinks no drug has such a distinct influence on the neuritic process as mercury—a grain of blue pill twice a day. Hot fomentations in the region of the nerve are of service for the pain; sodium salicylate and antipyrin may be given; morphia and especially cocaine, injected locally, are of great value. In the chronic stage counter-irritation by a blister, or the application of galvanism, is of service. A weak current should be used, the anode being placed over the affected nerve.[1]

Diseases and Injuries of Special Spinal Nerves

Phrenic nerve, see article on "Diaphragm."

Brachial plexus and its cords, see article "Brachial plexus."

Nerve to the Serratus Magnus (*Posterior or Long Thoracic Nerve*).—Paralysis of this nerve is produced by injury in the supraclavicular fossa or axilla. It may be due to injuries to the shoulder; it is occasionally produced through carrying heavy weights on the shoulder, especially if any sharp corner of the article has pressed into the supraclavicular fossa. Prolonged or violent muscular exertion with the arm raised has produced the paralysis, probably owing to severe compression of the nerve by muscular tissue through which it passes. The writer has seen the paralyses produced during parturition by prolonged and violent traction on a towel fixed to the head of the bed. Occasionally paralysis of the nerve has followed diphtheria, typhoid fever, influenza.

Symptoms.—At the onset there is sometimes neuralgic pain in the neck or about the shoulder. Lesion of the nerve causes paralysis of the serratus magnus muscle. On abduction of the arm to the horizontal position, the scapula on the paralysed side is nearer the vertebral column, and its posterior border is raised from the thorax. When the arms are put forwards horizontally in front of the chest the posterior edge of the scapula recedes from the thorax, causing a deep groove at this part. Elevation of the arm above the shoulder is much weakened; but if the lower angle of the scapula be pushed forwards and fixed by the hand of the examiner, the arm can then be raised vertically.

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[1] The affections of peripheral cranial nerves are described separately (*see* "Cranial Nerves" for Index).

Treatment.—The arm should be kept at rest, and it should be placed in a sling adjusted so as to slightly raise the shoulder. Galvanism may be employed after the early inflammatory changes have subsided.

The *supra-scapular nerve* is occasionally paralysed through injuries to the shoulder, falls on the hand, and exposure to cold. The symptoms consist chiefly in paralysis and atrophy of the supra- and infra-spinatus muscles. Through the wasting of these muscles the spine of the scapula appears very prominent. The paralysis of the supra-spinatus causes some impairment in the power of raising the arm, and a tired sensation after this movement. Paralysis of the infra-spinatus causes some impairment in the outward rotation of the humerus, which produces difficulty in moving the pen along the line in writing, and also difficulty in sewing.

The *circumflex nerve* may be paralysed through dislocation or injury at the shoulder, through the pressure of a crutch, and from exposure to cold; occasionally isolated paralysis of this nerve (through neuritis) occurs in diabetes mellitus.

The symptoms consist in paralysis of the deltoid muscle, with or without loss of sensation over the lower part of that muscle. The arm cannot be raised to the horizontal position. When an attempt is made to raise the arm into this position the shoulder is elevated by the trapezius and serratus magnus, whilst the arm hangs nearly vertically at the side. Ankylosis of the shoulder produces a similar inability to raise the arm; but the ankylosis can be easily detected by making passive movements. Bilateral paralysis of the deltoids has followed sleeping with the arms raised and the hands clasped behind the head. The writer has recorded bilateral paralysis produced by pressure through the patient being kept in bed in one position, on the back, for a month, on account of a fractured leg.

The Median Nerve.—This nerve supplies the two pronators, the flexors of the wrist and fingers (excepting the flexor carpi ulnaris and the ulnar half of the flexor profundus), the opponens, abductor, the long flexor, and outer head of the short flexor of the thumb, and the two radial lumbricales. When the nerve is paralysed above the point of origin of all the muscular branches, the muscles named are paralysed. Pronation is lost. The wrist cannot be flexed except to the ulnar side. The thumb is in an extended and abducted position, and cannot be opposed to the tips of the fingers. The patient is unable to flex the second phalanges of the fingers on the first; he is also unable to flex the distal phalanx of the first and second fingers; but he can flex this phalanx in the third and fourth fingers by means of the ulnar half of the flexor profundus which is not paralysed. He can flex at the knuckles by the action of the interossei. There is wasting of the thenar muscles. When the lesion of the nerve is below the origin of the branches to the forearm muscles, only the small muscles of the hand suffer.

The median nerve supplies the sensory fibres to the radial side of the palm, the front of the thumb, the first and second fingers, and half of the third; and in many persons to the back of the last phalanx of the index and middle finger; sometime also to the back of the last phalanx of the thumb and the back of the radial half of the last phalanx of the ring finger. The anæsthesia produced by lesion of the median is variable. Sometimes it corresponds to the sensory distribution named. In other cases the dorsal anæsthesia has extended over both the middle and end phalanges of the first and second fingers, over the radial part of these phalanges of the "third" fingers, whilst the back of the thumb has not been affected (Schultze).

Trophic change may occur in the skin and nails.

Causes of Paralysis.—Isolated lesion of the nerve is rare. Its causes are chiefly wounds and implication of the nerve in fractures of the bones of the forearm. In a few cases Esmarch's bandage has injured the nerve. Occasionally puerperal mono-neuritis has caused the lesion. In other rare cases it has been paralysed in certain occupations—in cigarette-makers, joiners, locksmiths, etc.

The Ulnar Nerve.—This nerve supplies the following muscles: flexor carpi ulnaris, the ulnar half of the flexor profundus digitorum, the hypothenar muscles, the interossei, the two ulnar lumbricales, the adductor and inner head of the short flexor of the thumb.

When the ulnar nerve is paralysed the hand deviates to the radial side on flexion at the wrist, and in time this deviation becomes permanent. Owing to the paralysis of the interossei and two ulnar lumbricales, the fingers cannot be flexed at the first joints (knuckles) or extended at the others. In this respect the first two fingers are less affected than the third and fourth, because their two (radial) lumbricales are supplied by the median nerve. In time the contraction of the opponents of the paralysed interossei produces over-extension of the first phalanges and flexion of the others, so that a "claw hand" developes. But the first two fingers have not the distinct claw position like the third and fourth fingers. The fingers cannot be adducted or abducted. The thumb cannot be adducted. The little finger cannot be opposed to the thumb, it cannot be abducted. The muscles of the hypothenar eminence are wasted, the palm of the hand is hollowed, and the depressions between the metacarpal bones are well marked.

The ulnar nerve supplies sensory fibres to the ulnar side of the hand (palmar and dorsal surface) and also to one and a half fingers on the palmar surface, and to two and a half on the back of the hand (counting from the ulnar side). The anæsthesia produced by paralysis of the nerve is variable, and not always proportionate to the lesion; according to Schultze the little finger is anæsthetic both on its palmar and dorsal surfaces; the ulnar half of the ring finger is anæsthetic on the palmar surface. On the back of the hand there is in addition anæsthesia over the whole of the proximal phalanx, and over the ulnar half of the two distal phalanges of the ring finger; also over the ulnar half of the proximal phalanx of the middle finger.

Causes of Paralysis.—The nerve may be injured by bone or callus through fractures of the lower end of the humerus or of its internal condyle, or by fracture of the bones of the forearm. Dislocation at the elbow or shoulder, wounds at the elbow or in the forearm, may implicate the nerve. Prolonged flexion of the elbow (during sleep) may cause paralysis of the nerve. In rare cases it has been paralysed through pressure at the elbow and through neuritis in the puerperium.

Anæsthesia in the region of the ulnar nerve sometimes occurs in general paralysis of the insane and in tabes dorsalis (Biernacki).

The *musculo-spiral nerve* is (owing to the great distance for which it lies upon the unyielding humerus) more commonly injured than is any other important trunk. Open wounds are by no means common, but it is especially liable to suffer from crutch paralysis, from dislocations of the shoulder and fractures of the humerus, and from sleeping with the arm thrown over the back of a chair or sofa, or beneath the back of its owner; as in the latter conditions sleep is generally alcoholic, a clear history of the circumstances must not be expected. The motor symptoms are essentially those of paralysis of the extensors of the wrist and fingers, and of the supinators of the wrist, the paralysed muscles being the supinator longus and brevis, the radial and ulnar extensors, extensor communis digitorum, and extensors of the thumb, index, and little fingers. If the lesion be high up, as in crutch paralysis, the triceps and anconeus are also affected; if it be below the origin of the branches to these muscles the wrist and hand will alone suffer. The position is characteristic: the wrist is flexed and pronated; the fingers and thumb are flexed upon the palm, but the terminal phalanges can be partially extended by the interossei and lumbricales if the wrist and proximal phalanges be supported. When the triceps is affected the elbow is slightly flexed and cannot be actively extended. Anæsthesia presents itself in the distribution of the external cutaneous branches on the outer side of the elbow and forearm, and in that of the radial nerve (*infra*). In the great majority of cases due to contusions, as from crutches or from sleeping in strained positions, the motor symptoms will alone be prominent; anæsthesia is often slight or altogether absent, and trophic lesions are very rare: such cases usually recover within a week or two.

The *radial nerve*, which is the principal sensory branch of the musculo-spiral, suffers with that trunk, and is liable to section in cuts about the wrist. Its distribution is sensory only, and includes that portion of the back of the hand and digits which lies to the radial side of the middle line of the ring finger, with the exception of the terminal portion of the digits supplied by overlapping branches of the median nerve.

The *lumbo-sacral plexus* is liable to injury by intra-pelvic growths, and by the pressure of the fœtal head during parturition; its branches are also often pressed upon by the exudation of sacro-iliac disease, and may be injured in fractures of the pelvis. Such conditions usually produce only neuralgiform pains with some weakness of the lower limbs. Paralysis and anæsthesia are rarely if ever complete, and the anterior crural and obturator divisions are much less susceptible of injury than is the great sciatic, while the pelvic organs suffer little as they receive a bilateral nerve-supply. The extent and distribution of the symptoms in the lower limbs present variations so wide as hardly to admit of description. Owing to the position of the cords of the plexus they are not open to operative treatment.

Owing to its deep position the *great sciatic nerve* is rarely injured, but it is extremely susceptible to pressure from disease. Its painful affections will be considered in the article upon sciatica, and the effects of injury are similar to those of combined lesions of the internal and external popliteal nerves.

The *anterior crural* nerve is rarely paralysed by injury or pressure; it supplies the extensor muscles of the knee-joint and the skin of the front of the thigh and inner side of the leg and foot.

The *external popliteal nerve* is liable to the ordinary results of disease and injury, and is especially prone to pressure from enlargement of the bursa beneath the biceps tendon, and to injury from tight bandaging and splints about the knee-joint, from fractures of the neck of the fibula, and from careless tenotomy of the biceps tendon. It supplies the extensor muscles of the ankle and toes, the peroneal muscles, and the skin of the dorsum of the foot.

The *internal popliteal nerve* is very rarely involved in disease or injury; it supplies the muscles of the calf, the flexors of the ankle and foot, and the muscles of the sole, while its cutaneous distribution is to the calf and sole.

TUMOURS

The term neuroma is commonly applied to tumours of two distinct pathological classes, viz. *true neuromata,* which consist of nerve elements, and *false neuromata,* pseudo-neuromata or neuro-fibromata, which originate in nerves, but are composed of a more or less modified connective tissue; the inflammatory swellings formed at the cut ends of nerves are also described clinically as "amputation neuromata," although they have nothing in common with true tumours.

A. *True neuroma* is an extremely rare form of tumour; it may consist either of cells resembling those of the central organs, or of fibres which may or may not be medullated, and thus we have three anatomical varieties—the ganglionic, the myelinic, and the amyelinic. Ganglionic neuroma is found only in close connection with the brain and spinal cord, and especially about the root of the nose or inner angle of the orbit; growths consisting of nerve-fibres are generally associated with the sympathetic system, and they also often contain ganglionic cells. All these rare tumours are generally met with at the time of or shortly after birth; they are well encapsuled, and are absolutely benign. Pathologically there can be no doubt that they are of the nature of congenital malformations due to displacement or irregular development of nervous structures. Although of little practical importance they may occasionally require excision, especially when they appear upon the face. It is interesting to note that dermoid cysts occasionally contain ganglionic cells.

B. The *false neuromata* are of greater frequency and importance. Omitting such inflammatory conditions as amputation neuroma and the lesions of leprosy and certain other infective diseases, we find a number of clinical varieties built up from a comparatively simple anatomical basis. They belong to the connective-tissue group, and thus constitute fibromata, myxomata, lipomata, or sarcomata. They may be localised and encapsuled, or they may be widely diffused and disseminated along nerve-trunks in one or more regions of the body. They arise from the stroma of the nerves, and merely push aside the fibres of the latter, any proliferation of nervous tissue which may be met with being probably incidental and devoid of significance.

I. The *circumscribed or solitary tumours* are generally simple fibromata; they may present myxomatous or fatty elements, or contain degeneration or extravasation cysts, and they may be sarcomatous. Angioma and lymphangioma are mere pathological curiosities. They are, as a rule, well encapsuled, of slow growth, and of comparatively small size. Such tumours are generally extremely painful and tender, but they do not, as a rule, cause any marked paralysis, anæsthesia, or trophic changes, except in the case of rapidly growing sarcomata. Their recognition depends mainly upon the site of the growth, the association of nervous symptoms, the eliciting of pain, cramp, etc. upon pressure, and their marked lateral mobility as contrasted with their fixation in the axis of the nerve. Excision is practicable in most cases, but often involves resection of a considerable portion of the affected nerve, so that it may become a question whether the resulting lesion is or is not of more serious nature than the tumour itself. In some cases it is practicable to shell out the encapsuled growth, leaving intact the nerve fibres, which lie to one side or scattered over its surface.

A peculiar form of tumour is the painful subcutaneous nodule of Wood, which is a small, hard fibroma, probably developed upon a terminal sensory branch. Such growths are extremely painful, and lying as they do immediately beneath the skin, they are prone to irritation. They are sharply circumscribed, and in no way malignant.

Circumscribed neuromata may arise within the vertebral canal upon the nerve roots, and especially upon the cauda equina, in which case the pressure resulting from their confined situation leads ultimately to paraplegia, which is capable of relief by operation.

II. The *diffused or generalised* neuro-fibromata are also spoken of as neuro-fibromatosis, and various forms have received special designations from different writers. These masses are again fibromatous, myxomatous, or sarcomatous. They are generally multiple, and widely scattered throughout the nervous system. They may appear as numerous isolated masses, or as extensive infiltrations of certain trunks, or of the nerves of certain regions. Commonly hereditary, they may be congenital, and probably all cases are due to developmental peculiarities—to a "form of gigantism or elephantiasis of the connective-tissue elements of the peripheral nervous system." In many cases, also, they are associated in their development with pre-existing cutaneous moles, and pigmentation of the superjacent skin is a very common accompaniment of these growths. They are seldom very painful or tender, nor do they, unless sarcomatous, usually produce marked disturbance of the nervous functions, but they become important from their multiplicity, their large size, their tendency to sarcomatous degeneration, the difficulty or impossibility of their excision, and their occasional involvement of the central nervous organs.

1. *Molluscum fibrosum* is a form of neuro-fibromatosis, presenting itself in the form of multiple subcutaneous masses of soft fibroma or fibro-myoma, with which may be associated similar masses on the deeper nerve trunks. The subcutaneous nodules, which vary greatly in size, number, and distribution, are probably derived from the stroma of the smaller cutaneous nerves. They cause comparatively slight symptoms, and may persist for an indefinite number of years without producing results more serious than disfigurement.

2. *Plexiform neuro-fibroma* is a growth of similar nature, but differs in that, instead of forming numerous masses over the entire surface of the body, it is restricted to some one region, as the side of the head and neck. These masses grow to an enormous size, but still consist of fibrous, fibromyxomatous, or fibro-sarcomatous growths of the nerves of the affected region. They form soft, doughy, often pendulous tumours composed of ramifying cords due to the huge nerves which produce their bulk. Closely allied is *elephantiasis neuromatosa*, in which the tumour growth spreads from the nerves to the subcutaneous and other adjacent tissues, producing a general thickening which is also described as pachydermatocele.

The great majority of these forms of diffused and disseminated neuro-fibroma are not susceptible of removal, and operation is the less advisable, as it is commonly followed by rapidly infiltrating sarcomatous growths in such portions of the mass as may have to be left behind. When they affect the limbs amputation is the most satisfactory method of treatment of severe cases.

MERALGIA PARÆSTHETICA

A few years ago Bernhardt drew attention to a rare affection, characterised by paræsthesia, in the distribution of the external cutaneous nerve of the thigh. The patients complain of numbness, tingling or aching sensation, along the outer side of the thigh. Pain is only felt on great over-strain, or through pressure on the affected region. Often there is some objective disturbance of sensation—hyperalgesia, hyperæsthesia, diminution of tactile sensation or of the temperature sense.

The paræsthesia is most marked, or is only present, when the patient is standing or walking, probably because the fascia of the outer part of the thigh is then most tense. Pain does not occur when the patient is at rest.

Roth has given the name meralgia paræsthetica to the affection.

The duration is variable, from a few months to many years. It is not followed by any other nerve lesion. In two cases faradism at the paræsthetic area has been followed by good results.

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GENERAL ETIOLOGY.—The most frequent cause of multiple peripheral neuritis is the action of some toxic substance on the nervous system. The most common form is "alcoholic" neuritis, produced by excess of alcoholic beverages—spirits and beer.

Chronic poisoning by lead and arsenic are also common causes of peripheral neuritis. Rare cases have been recorded in which the disease has apparently been due to poisoning by the following substances—carbon disulphide, naphtha, dinitrobenze, aniline oil, carbon monoxide, mercury, (? copper, zinc, and silver).

The disease may be due to a previous infectious fever or acute illness. Diphtheria is the most common cause of neuritis of this form. Cases are on record in which paralysis, apparently due to peripheral neuritis, has followed, and has been attributed to, typhoid fever, influenza, erysipelas, septicæmia, scarlet fever, pneumonia, acute rheumatism, gonorrhœa, malaria, dysentery.

The tropical disease beri-beri is a form of peripheral neuritis.

Multiple neuritis occasionally follows parturition or develops during pregnancy (puerperal neuritis).

A form of multiple neuritis associated with diabetes mellitus has been clearly demonstrated.

Tuberculosis has occasionally caused multiple neuritis; and a few rare cases are on record in which the disease has been attributed to syphilis, gout, and chronic rheumatism (Bury).

In leprosy peripheral neuritis is common.

In rare cases of severe anæmia and in cancer, degeneration of the peripheral nerves has been found on microscopical examination, but often there have been no neuritic symptoms during life.

In old age a form of peripheral neuritis has been described, which has been attributed to arterio-sclerosis.

Occasionally the only cause appears to be exposure to cold; and there are cases for which no cause can be made out (idiopathic multiple neuritis).

Oppenheim and, more recently, Remak have drawn attention to the fact that a combination of toxic influences, such as lead or other metallic poison with alcohol, or of alcohol and the poison of some infectious disease, is particularly powerful in producing neuritis. A small dose of a poison, which cannot be regarded as toxic, is able to produce multiple neuritis when the individual is also under the influence of a second poison.

Multiple neuritis occurs most frequently in individuals between the ages of twenty-five and fifty; with the exception of the diphtheritic form, it is very rare in children.

General Pathology.—The symmetrical nature of the motor and sensory symptoms in multiple neuritis points to an altered blood condition as the cause. The etiology shows that this altered blood condition is due most frequently to the presence of a definite toxic substance. In the cases in which the neuritis follows an infectious disease, the cause is probably a toxin produced by the action of micro-organisms, and this has been proved in the case of diphtheria.

Multiple peripheral neuritis is characterised pathologically by degeneration of the finest branches of the peripheral nerves—in other words, by degeneration of the most distal part of the axon of the lower or peripheral neuron. This is the chief change. The degeneration rapidly diminishes towards the cord, and the larger nerve trunks, and the nerve-cells of the anterior horns of gray matter often appear quite normal, even when examined by the most modern methods of staining. In other cases slight changes are noted in the nerve-cells, which are often probably secondary to those in the peripheral portions of their axons (the finest peripheral nerves). The poison causing neuritis frequently affects other parts of the system besides the finest peripheral nerves (as the brain in alcoholic neuritis). Hence slight changes found in nerve-cells of the cord have been attributed, in some cases, to the primary action of the poison.

Forms of Multiple Neuritis.—Four forms have been described according to the nature of the most prominent clinical symptoms—(1) mixed sensory and motor, (2) sensory, (3) motor, (4) ataxic (pseudo-tabes).

Also acute and chronic forms have been described according to the onset; and ascending and descending forms according to the course of the symptoms. But it appears most practical to describe the symptoms separately, according to the cause.

ALCOHOLIC MULTIPLE NEURITIS.—The most common form of multiple neuritis is that produced by the drinking of alcoholic beverages—"alcoholic" peripheral neuritis. It is caused by excess of spirits or beer, and it is stated that wine may produce it also. In Manchester, during the year 1900, a large number of cases of peripheral neuritis occurred in persons whose alcoholic beverage was exclusively or chiefly beer, ale, or stout. At the end of 1900 Dr. E. S. Reynolds made the interesting and important discovery that Manchester beer contained arsenic, and it was soon found that a large quantity of the beer sold in the north of England and midland counties was also contaminated more or less with arsenic. As arsenic is a poison which is capable of producing neuritis, this discovery naturally has received much attention. [Multiple neuritis from arsenical beer will be subsequently considered.] Apparently it has not hitherto been the custom to test beer for arsenic as an impurity, and it is impossible to say, of course, how much of the multiple neuritis from beer drinking in the past has been produced by arsenical beer. Whether beer free from arsenic is capable, in large quantities, of producing multiple neuritis (as has been generally believed hitherto) will be clearly shown by future experience, as for many years, at least, beer sold in England will be free from arsenic.

As regards the etiology of alcoholic neuritis, we are therefore limited, at the present time, to the consideration of cases from the drinking of spirits; and even the importance of alcohol *per se* has been recently called in question by Dr. Reynolds since arsenic was discovered in beer.

Many of the earlier cases of peripheral neuritis, recorded when the disease first began to attract attention, were in spirit drinkers. Sir W. Gowers and many other writers state that alcoholic neuritis results chiefly from the stronger forms of alcohol, especially spirits. The late Dr. Ross, in an analysis of 90 cases (77 of which were collected from medical literature) found the form of alcoholic beverage to be given as follows: in 22, spirits—brandy, whisky, gin, or rum; in 3, absinthe or vermouth; in 13, beer and spirits; in 5, beer only; in 47, the form of alcohol was not stated. [In Manchester, of course, there can be no doubt that for many years beer alone (? arsenical or non-arsenical) has been very much more frequently the cause of multiple neuritis than would be indicated by the figures just mentioned.]

There can be no doubt that multiple neuritis occurs in intemperate individuals whose chief alcoholic beverage is spirits. The writer is unable to obtain definite statistics as to whether multiple neuritis is more frequent or less frequent in countries where the chief alcoholic drink is stated to be spirits. In Scotland it is generally believed that spirits are drunk much more freely than in England, and certainly the statistics in the Edinburgh hospital reports do not indicate that the disease is less frequent there than in London.

[During five years (1892-97) at the Edinburgh Royal Infirmary there were 24,065 medical in-patients, and of these 144 suffered from alcoholic peripheral neuritis—ratio, 5·9, nearly 6 in every 1000. At St. Thomas's Hospital, London, during five years (1894-98) there were 9450 medical in-patients, and of these 34 suffered from alcoholic neuritis, 9 from peripheral neuritis of doubtful origin, *i.e.* 43 cases possibly due to alcoholic neuritis—ratio, 4·5 per 1000.]

There are two other questions with regard to neuritis from spirit drinking which may be here referred to:—(1) It may be asked, Are not spirit drinkers frequently beer drinkers also, and if so, may not the neuritis be due to arsenical beer rather than spirits? (2) If neuritis is produced by spirits only, is it due to the alcohol, or to the presence of arsenic as an impurity? With regard to the first question it must be admitted that spirit drinkers frequently take beer also. There have been numerous cases, however, in which the influence of beer can be almost excluded. But quite recently, since so much attention has been paid to this question, several cases of neuritis from spirit drinking have been already published, in which beer can be *definitely* excluded as an etiological factor. As regards the second question, the writer is not aware that any analysis of spirits has yet shown the presence of arsenic.

In a case of peripheral neuritis from excessive whisky drinking recently recorded by the writer, in which the diagnosis was verified by microscopical examination of the peripheral nerves, beer drinking could be definitely excluded in the causation. Also three samples of whisky obtained from the same source as that from which the patient was supplied, gave no reaction for arsenic with Reinsch's test. Hence there appears to be no reason for doubting the correctness of the common opinion that alcoholic beverages, especially spirits, are capable of producing peripheral neuritis apart from arsenic as an impurity.

To be strictly logical, it has not been definitely proved that *pure ethyl alcohol* produces peripheral neuritis in man, since no one takes pure ethyl alcohol as a beverage. Whether the ethyl alcohol or some organic impurity, such as furfural, is the chief toxic agent in the production of neuritis from spirit drinking remains to be decided. But until it has been clearly shown that ethyl alcohol is not the cause, it appears justifiable to describe by the name alcoholic neuritis all those cases of peripheral neuritis from the drinking of alcoholic beverages, in which there is no evidence of the presence of any other poison known to be capable of producing neuritis.

Symptoms.—The onset is usually somewhat gradual or subacute, rarely rapid. The patient complains of numbness and tingling (or of "pins-and-needles sensation") in the toes and fingers, which also feel "dead." He suffers from cramps especially in the calf muscles, and from gnawing or tearing pains in the limbs, especially in the legs. The pains are increased by movements and by pressure. When the muscles of the calf are grasped great pain is produced (muscular hyperalgesia). Sometimes touching the skin produces pain. Often there is hyperæsthesia, especialy of the feet, which renders walking difficult. Slight constitutional disturbance, with a little elevation of temperature, may be present for a short time just at the commencement of the affection.

Soon signs of muscular weakness are noted in addition to the sensory symptoms. The toes become "dropped," and there is difficulty in extending them. The feet become "dropped," and the patient cannot dorsiflex them. In walking, the feet are dropped, and the knees must be raised unusually high in order to clear the dropped feet from the ground (high-stepping gait). Occasionally the gait is somewhat ataxic (*névro-tabes périphérique*). The knee-jerks are lost early. (Occasionally, just at the earliest stage, the knee-jerks are present or even a little increased; but they usually disappear very soon). The weakness in the legs gradually increases until walking is impossible.

When the disease has become well developed the patient presents the following symptoms:—

Motor.—Both legs are symmetrically paralysed. The peronei and anterior tibial muscles are most affected. The feet and toes are bent towards the sole and cannot be bent upwards (cannot be dorsiflexed) towards the ankles—dropped feet and toes. Often the feet are a little inverted because the tibialis anticus muscle is less affected than the other muscles on the front of the leg. The tibialis anticus tendon is often prominent, and the patient is sometimes able to slightly invert the foot when he is unable to dorsiflex it. In the less severe forms the patient can flex at the hips and knees; but in advanced cases the legs may be almost completely paralysed, the patient being able to perform slight movements at the hips only. The muscles of the legs, especially those of the anterior tibial group, undergo atrophy. On electrical examination the affected muscles often present a diminution of faradic and galvanic excitability: with the galvanic current the K.C.C. may be greater than A.C.C. as in health; or the K.C.C. and A.C.C. may be equal. A reaction of degeneration (with absence of faradic excitability, and A.C.C. > K.C.C.), but with diminution of galvanic excitability, occurs only in advanced cases. In the most severe forms, the muscles chiefly implicated may lose all excitability both to faradism and galvanism. The excitability both to galvanism and faradism in the nerves is diminished and finally lost. The knee-jerks are absent; the plantar reflexes are very feeble or absent; ankle clonus is absent.

In many cases the arms are not affected; in severe cases both arms are paralysed, but not so markedly as the legs. The extensors of the fingers and wrists on both sides are most affected, as in lead paralysis; the wrists and fingers are dropped, and the patient is unable to extend them. The dropping of the fingers is most marked in the little finger, and gradually becomes a little less from the little finger to the index finger. The supinator longus is spared in many cases just as in lead paralysis.

In severe cases the flexors of the fingers and wrist are affected more or less; but the flexor muscles of the elbow and the upper arm muscles are rarely involved. In rare cases the small muscles of the hands are affected.

The paralysis of the legs and arms is bilateral and symmetrical.

The intercostal and abdominal muscles are unaffected. The bladder and rectum are not paralysed. In a few rare cases there has been slight difficulty in micturition or a little dribbling of urine; but true retention or incontinence does not occur.

Sensory.—When the neuritis is fully developed the early subjective sensory symptoms, already mentioned, persist. There are severe pains in the affected limbs, of a gnawing or tearing character, and these are increased by passive or active movements, or by touching the limbs. Superficially situated nerve trunks may be tender, and are occasionally thickened.

A prominent symptom in most cases is the intense pain caused by squeezing the muscles, especially those of the calf (muscular hyperalgesia): it is best marked in the legs, but the arms often suffer also. In rare cases this symptom is slight.

The patient also suffers from numbness and tingling in the legs and arms. Tactile sensation in the limbs is diminished and finally lost in severe cases, but complete anæsthesia in large areas is rare. The impaired sensation when present is most marked at the periphery of the limb, and gradually gives place to normal sensation towards the proximal part. When sensibility to tactile impression is dimished, often there is hyperæsthesia for pain.

Sensory symptoms are occasionally very slight, whilst the motor are well marked (motor form of the disease). Sometimes diminished sense of the position of the toes is the only objective sensory symptom (Oppenheim).

Hyperæmia, with sweating of the hands and feet, are common symptoms, and occasionally the skin becomes glossy. In a few cases ulcers have developed on the feet. Sometimes in severe cases there is a little œdema of the feet and exceptionally a little effusion into the joints.

Girdle sensations do not occur. Bed sores very rarely occur, and when present they are superficial. There is no spinal curvature or pain. The pupils are usually normal, and react well to light and accommodation (but diminution or loss of the latter reflex has been recorded by Sir Lauder Brunton). Generally there is no paralysis of the facial, ocular, and tongue muscles. Very rarely double facial paresis has been recorded, and in a few exceptional cases there has been paralysis of ocular muscles. Nystagmus is not infrequent. The optic discs are nearly always normal; but in very rare instances optic neuritis has been recorded, or partial optic atrophy with pallor of the temporal half of each disc. Central scotomata for colours have been also recorded in a few cases.

Psychical symptoms (polyneuritic psychosis of Korsakow) are often present, such as mental confusion, impairment of memory—especially for recent events,—and delusions about recent actions. Thus a patient who has been confined to bed for weeks or months, and who is so confused mentally as to be unable to tell the day, date, or month, or her address, will often give a detailed account of a walk she declares she has had the same or the previous day, stating the houses she has visited, the friends she had met, and the drinks she has had.

In most cases of alcoholic neuritis, sensory and motor symptoms are combined (mixed form). In the early stages the sensory are the most prominent, and occasionally the motor symptoms never become marked (sensory form). Occasionally the motor symptoms are prominent and the sensory very slight (motor form). In a rare form ataxia of the legs and arms is the most prominent symptom (pseudo-tabes); but in such cases motor and sensory symptoms are present, though slight, and clearly indicate the nature of the disease.

Course and Prognosis.—In most cases a few weeks elapse before the disease reaches its fullest development, then for a long period the affection is stationary, and finally gradual recovery occurs. Usually the termination is in partial or complete recovery, but the peronei often remain weak long after the other muscles have recovered. Sometimes permanent contraction of the calf muscles leads to deformity of the feet.

In many cases, however, a fatal termination occurs. This may be due to paralysis of the diaphragm, tuberculosis of the lungs, cardiac failure, disease of the liver, or pneumonia.

When the diaphragm is paralysed the epigastrium and upper part of the abdomen *sink* in at each inspiration and the descent of the liver can no longer be felt. The abdomen protrudes and the liver descends on *expiration.* Expectoration and coughing become difficult; there is also difficulty in straining at stool and on micturition. A basal pneumonia often develops.

[In normal *quiet* breathing, when the patient's attention is *not directed* to the respiratory movements, at each inspiration the chest expands, and the abdomen is protruded just below the ribs and the viscera descend.]

Alcoholic heart muscle failure may lead to œdema of the legs and other signs of cardiac disease (see article on "Cardiac Disease").

Tuberculosis is a most serious complication. It is incurable and is a very common cause of the fatal termination in peripheral neuritis. It is often latent for a long period at first and the pathological lesions are usually much more extensive than is suspected from the clinical signs.

The *diagnosis* of alcoholic neuritis in a marked case is easy. Symmetrical bilateral flaccid paresis or paralysis, with dropped feet, dropped wrist, absent knee-jerks, and great muscular hyperalgesia, is always very suggestive of peripheral neuritis, when the bladder and rectum are unaffected.

The diagnosis from transverse or compression myelitis and from other transverse lesions of the cord is easy when these affections give rise to a spastic paralysis. In such cases the increased knee-jerks, ankle clonus, rigidity of the legs (or spastic gait), and the paralysis of bladder and rectum exclude peripheral neuritis. The chief difficulty is when these cord affections are in the lumbar region or when they give rise to flaccid paralysis with absent knee-jerks. In such cord lesions the bladder and rectum are paralysed and deep sacral bed-sores often develop; whilst these symptoms are absent in peripheral neuritis. Also in peripheral neuritis there is the marked muscular hyperalgesia and often the mental symptoms already described; a girdle sensation is absent; as the affection extends to the upper part of the body the wrists are dropped before the intercostals are paralysed; and the anæsthesia is most marked in the periphery of the limbs, and gradually fades away towards the proximal part. In the cord affections mentioned muscular hyperalgesia is absent or slight; the intercostals are paralysed before the arms in the upwards extension of the disease, and the anæsthesia is often sharply limited to the distribution of definite nerve roots.

In acute anterior poliomyelitis of the adult the sudden onset of the paralysis, the absence of muscular hyperæsthesia, and the absence of anæsthesia or sensory disturbances are usually sufficient to separate the affection from peripheral neuritis.

The diagnosis from tabes dorsalis requires to be considered chiefly in the ataxic form of peripheral neuritis. In favour of true tabes dorsalis would be the Argyll-Robertson pupil, the sharp, shooting nature of the pains in the legs, the absence of true paresis or paralysis, the girdle sensations, and (if present) optic atrophy. In peripheral neuritis the pupils almost invariably react to light; there is distinct paresis with some dropping of the feet and high-steppage gait (even in the ataxic form); also the muscular hyperalgesia, the gnawing character of the pains, the absence of girdle sensations, the absence of crises, the history of alcoholic excess and the more rapid development of symptoms would point to peripheral neuritis.

In the early stages of alcoholic neuritis, when pain is the chief symptom, the affection may be mistaken for rheumatism. In peripheral neuritis the pain is in the muscles; in articular rheumatism in the joints. Marked muscular hyperæsthesia, absent knee-jerks, numbness and tingling, dropping of the toes or feet, and the bilateral and symmetrical nature of the affection would be in favour of peripheral neuritis.

The diagnosis of alcoholic neuritis from other forms of peripheral neuritis depends chiefly on the history; also indications of other poisons, or in some cases peculiarities in the symptomatology may be of diagnostic value (see other forms of neuritis).

The alcoholic beverage should be examined for arsenic when the amount taken has been small or the form chiefly beer.

Pathological Anatomy.—Changes are constantly found in the peripheral nerves, sometimes also in the muscles and central nervous system. But the changes in the central nervous system are inconstant and usually slight; those in the peripheral nerves the most advanced, consisting of a neuritis, generally of the parenchymatous or degenerative form.

For transverse section the nerves may be hardened in Müller's fluid and stained according to Weigert's method. A simple method of examination of the peripheral nerves is by fixing and staining directly in a 1 per cent osmic acid solution, and afterwards staining with alum carmine or picro-carmine. The finest muscular branches should be carefully removed and placed directly in the osmic acid. The muscular branches of the anterior tibial or musculo-spiral nerve are suitable for examination. The changes are best seen in the finest muscular and cutaneous branches; they diminish greatly in intensity in the larger branches, and may be absent in the large nerve trunks. The parenchymatous neuritis is best marked in the nerves of the limbs (such as the branches of the anterior tibial or the musculo-spiral). The writer has found it also in the phrenic nerve when death has occurred from paralysis of the diaphragm. It has been occasionally found in the vagus nerve.

In the affected nerves the myelin of the white substance of Schwann is broken up into small globular, oval, or irregular masses, and in advanced cases the axis cylinder is also broken up. The nuclei of the nerve-fibres undergo proliferation. In advanced cases the nerve sheath contains only proliferated nuclei and clusters of fatty globules from the degenerated myelin. In some fibres the globules of degenerated myelin are collected at intervals into spindle-shaped swellings, separated by naked axis cylinders or empty nerve sheaths. An increase of the connective tissue of the nerve-fibres is rare. But occasionally, in addition to the parenchymatous changes just described, a broadening of the perineurium, or an increase of the interstitial fibrous tissue between the nerve-fibres, has been observed, *i.e.* a combination of parenchymatous and interstitial neuritis. Hyperæmia and swelling of the affected nerves is very rare.

The muscle tissue on microscopical examination often appears normal. Sometimes changes are observed. The muscular fibres may be simply diminished in size, the transverse striation being preserved. Or the transverse striation may be lost, the fibre degenerated, the nuclei of the sarcolemma and perimysium proliferated, and the perimysium broader than in the normal condition. The diseased fibres are often mixed with normal fibres. In a few cases marked muscular changes have been observed—granular and fatty degeneration of the muscle fibres, with marked proliferation of interstitial nuclei and interstitial connective tissue (marked parenchymatous and interstitial muscular changes). The blood-vessels in the nerves and muscles are often normal, but they may present thickening of all their coats, with surrounding cell proliferation. When the lumen of the vessels is greatly narrowed the vascular changes may then increase those in the nerves and muscles. Vascular changes, when present, are seen in other parts also.

Microscopical changes in the central nervous system are rare, and when present are usually slight. By the older methods of examination the cord and its nerve-cells usually appear quite normal.

[In a few rare cases recorded by Leyden, Oppenheim, and others, in addition to the peripheral neuritis there was atrophy of the cells of the anterior horns, or diffused or disseminated patches of inflammation, or patches of poliomyelitis. But such changes have been too rare or too slight to throw any doubt on the peripheral nature of the disease.]

By recent methods of examination slight changes have been sometimes found in the spinal cord when stained according to Nissl's method. Disappearance of the Nissl's granules of the nerve cells of the anterior horn has been observed along with a lateral displacement of the cell nucleus. These changes are probably secondary to those in the peripheral nerves (*réaction à distance of Marinesco*). They are not constant (Déjerine and Thomas). By staining the cord according to Marchi's method degenerated fibres have been sometimes found, especially in the posterior columns (Campbell, Soukhanoff), in Lissauer's zone, and occasionally in other parts.

Arsenical Neuritis.—This form of multiple neuritis has followed acute arsenical poisoning from a single large dose of arsenic. In other cases it has been due to chronic poisoning from pigments containing arsenic, and from various forms of slow poisoning. Occasionally it has been produced by arsenic given in large medicinal doses for chorea and other affections. Osler states, however, that only one case has followed the use of liquor arsenicalis in his hospital practice, although he is "in the habit of giving, in chorea and anæmia, doses which might be regarded as excessive." Amongst 312 cases of chorea treated with liquor arsenicalis, Railton has met with three cases of arsenical neuritis, and he states that many other children had the same or larger doses of arsenic without neuritis being produced.

[Neuritis from arsenical beer is considered in the next section of this article, page 301.]

Symptoms.—In some cases the neuritic symptoms have developed a few days or a few weeks after the gastro-intestinal symptoms produced by acute poisoning. In other cases the gastro-intestinal symptoms have been slight or absent, and the neuritic symptoms have developed gradually. Sometimes conjunctivitis is present at the onset. The nervous symptoms commence with pain, numbness, and tingling in the legs, or legs and arms (most marked in feet and hands). The pain is often greater than in alcohol neuritis, and is both superficial and deep-seated in the limbs. The muscles and superficially situated nerves are very tender on pressure. Loss of power develops in the legs, and the feet are dropped just as in alcoholic neuritis. The arms are often paralysed; the common extensor muscles of the forearm are most affected, and there is double-dropped wrist. But the flexors and the small muscles of the hand are often paralysed also, and this occurs more frequently than in alcoholic or lead neuritis. Usually there is paresis or paralysis in all four limbs. Sometimes the paralysis is limited to the legs, but it is scarcely ever limited to the arms. The affected muscles undergo atrophy. Fibrillary twitchings are said to be more frequently present than in alcoholic or lead neuritis. On electrical examination there is a diminished excitability, or a reaction of degeneration may occur. The knee-jerks disappear; the plantar and cremasteric reflexes are diminished or absent.

In addition to the sensory symptoms already mentioned there is often hyperæsthesia, which is followed by diminution or loss of tactile sensation. Hyperalgesia is often present, or there may be hyperalgesia with loss of tactile sensibility.

Ataxia is often noted, and it is sometimes a prominent symptom; usually it is combined with motor paresis.

Sweating of the hands and feet is common. The skin may become glossy, and often other skin affections are observed, such as pigmentation (diffused bronzing, like that in Addison's disease, or circumscribed small pigmented spots), erythema, herpes zoster, hyperkeratosis. There is often falling off of the hair. The pigmentation and skin lesions are not always present.

Diagnosis.—In all cases of neuritis of doubtful origin the possibility of arsenic being the cause of the neuritis should be considered. If arsenic is entering the system it may be possible to detect it in the urine. (The writer has detected arsenic in the urine by Reinsch's test when only three minims of liquor arsenicalis were being taken three times a day.) It may also be detected in some cases in the hair, nails, and desquamating epidermis. Gastro-intestinal symptoms, or conjunctivitis at the onset, or the presence of pigmentation of the skin or herpes zoster, may indicate the diagnosis. The examination of food or beverages for arsenic may be necessary in doubtful cases.

The prognosis is favourable. Recovery usually occurs if the entrance of arsenic into the system is stopped. Secondary contraction of the flexor muscles of the hands and feet may cause troublesome deformities.

Pathological Anatomy.—In the few cases on record in which microscopical examination of the nervous system has been made, the changes found have consisted of a parenchymatous neuritis of the peripheral nerves, with atrophy of nerve-cells and fine nerve-fibres in the anterior horns of gray matter. In one case there was also degeneration in the columns of Goll.

EPIDEMIC OF PERIPHERAL NEURITIS DUE TO BEER CONTAINING ARSENIC.—During the later half of 1900 a number of medical men in Manchester noted a great increase in the cases of peripheral neuritis in their practices. Apparently about the same time several medical men formed the opinion that probably some unusual toxic substance was present in Manchester beer. But to Dr. E. S. Reynolds the credit is due of first suggesting that the beer contained arsenic, and of first detecting the presence of arsenic in it. Many cases coming under the care of Dr. Reynolds at the Manchester Union Infirmary presented pigmentation and other affections of the skin suggestive of arsenical poisoning. In the practices of other medical men these associated skin affections were absent or much less frequent. In 1888 an epidemic occurred at Hyères owing to white arsenic being put into wine instead of gypsum.

Dr. Reynolds concluded that in Manchester and district there was a widespread and unusual epidemic of peripheral neuritis "associated with running of the eyes and nose (in many cases), and marked lesions of the skin," that the affection was only met with in drinkers of beer and porter, and that the cases differed from ordinary "alcoholic" paralysis by the "greater amount of sensory and vaso-motor disturbance, and especially in the presence of the peculiar skin lesions which are not usually present in alcoholic paralysis." He attributed the epidemic to the arsenic which he had found to be present in the beer.

The presence of a small quantity of arsenic in beer was at once confirmed by others; it was found also in stout and ale. Through investigations carried out by Professor Délepine, Dr. Coutts, Mr. Tattersall, and Professor Dixon, the arsenical contamination was shown to be caused by the use of sulphuric acid, containing arsenic as an impurity, in the preparation of the glucose and invert sugar used in the brewing of the cheaper kinds of beer. One specimen of sulphuric acid contained as much as 1·4 per cent of arsenic (estimated as arsenious oxide); the glucose, 0·8 parts per 1000; and the invert sugar, 0·25 per 1000. Various specimens of beer were found to contain from 0·14 to 0·3 grains per gallon; a few examined later by other chemists were found to contain a larger amount—up to 1 grain per gallon. It was found that only the glucose made by one firm of sugar manufacturers was contaminated. As this firm supplied a large number of breweries in the North of England with the glucose used in brewing, the contamination of most of the beer was explained. In a few specimens of arsenical beer the contamination was traced to arsenic in the malt.

The following cases of neuritis from arsenical beer may be mentioned as examples of the forms met with:—

1. Female, aged thirty.—For five years had taken one kind of stout and very rarely any other form of alcoholic beverage. Great excess denied. Making allowance for under-estimation, it is probable that amount was much less than four pints daily. Onset of illness with conjunctivitis: it was also noted that the stout caused diarrhœa. Nervous systems similar to those of alcoholic neuritis. Legs and arms paralysed; dropped feet and dropped wrist; inability to walk; absent knee-jerks; muscular hyperalgesia, etc. On examination of specimens of the kind of stout taken, the writer found distinct evidence of arsenic by Reinsch's test.

2. Male, slight form.—Severe gnawing pains in legs and arms; great tenderness of muscles; inability to walk owing to pains in feet and legs; knee-jerks present; no anæsthesia; no true paralysis; no pigmentation; history of beer drinking (great excess). On the first examination of the urine there was evidence of a small quantity of arsenic by Reinsch's test. Rapid recovery by rest in bed and abstinence from beer.

3. Female.—Neuritic symptoms like those of alcoholic neuritis. Bronzed diffused pigmentation, chiefly on chest.

Symptomatology.—In some cases gastro-intestinal symptoms—vomiting and diarrhœa—were noticed at the onset of the illness; in other cases, conjunctivitis. But usually these symptoms were absent or indefinite. In many cases there was a condition of the feet resembling erythromelalgia. The soles of the feet were often very red, tender, and painful, and bathed in perspiration; sometimes the palms of the hands were affected in the same way. Herpes zoster (unilateral) was present in a small proportion of the cases. Erythema, diffused or circumscribed, and hyperidrosis were often noted. In some of the cases the skin was pigmented, presenting a diffused bronzed discoloration, like that of Addison's disease, or circumscribed macular or punctate pigmentation. Hyperkeratosis was the skin affection *par excellence* (Brooke and Leslie Roberts). It was best developed in the soles and palms which presented great thickening of the epidermis, with thick desquamating scales. In some cases there was a combination of erythema or pigmentation with the hyperkeratosis.

The nervous symptoms were much the same as those of alcoholic neuritis. Of the sensory symptoms, pain in the limbs and feet, and great tenderness (hyperalgesia) of the muscles, were very prominent. The knee-jerks were often present and increased at first for a very short period; afterwards they disappeared.

In addition to the detection of arsenic in the beer taken by many patients who suffered from neuritis from beer drinking, careful examination revealed the presence of this poison in the urine in a number of cases. Professor Dixon Mann and others found arsenic present in the desquamated epidermic scales and also in the nails and hair. Post-mortem examination in some of the cases, but not in all, revealed a small quantity of arsenic in the internal organs. (For the detection of arsenic in beer and urine Reinsch's process appears to be the most convenient for the medical practitioner.)

A review of all the evidence published with respect to the peripheral neuritis in Manchester during the latter half of 1900, shows clearly that the increased prevalence of the disease can be largely attributed to the presence of arsenic in the beer.

The analyses made by Mr. Kirkby of the kinds of beer which had been taken by a number of patients suffering from peripheral neuritis gave an average of about 0·11 grain per gallon of arsenious oxide. The highest was 0·28 grain per gallon, the lowest 0·01 grain per gallon. Figures published by Professor Délepine gave the amount of arsenic as 0·14 to 0·3 grain per gallon. Afterwards, in several instances, larger quantities of arsenic were found.

Many of the patients had taken very large quantities of beer, 1 to 1½ or 2 gallons daily. As English beer contains usually about five per cent of alcohol, any individual taking one gallon of beer daily would consume about eight ounces of ethyl alcohol (equivalent to about sixteen ounces of brandy daily)—an amount of alcohol which would appear to be sufficient to cause neuritis apart from any arsenical contamination. All who believe that alcohol is capable of producing neuritis must admit that when the patient has taken very large quantities of arsenical beer—more than a gallon daily—the resulting neuritis must be attributed in part, at least, to the alcohol. The arsenical contamination would of course increase the toxic action of the alcohol. In the case of the most contaminated specimens of beer examined by Dr. Délepine, a person consuming more than one gallon would take daily an amount of arsenic greater than that contained in ten minims of liquor arsenicalis three times a day. It is little wonder that the combination of the amount of alcohol just mentioned with this quantity of arsenic produced severe forms of neuritis. But in most of the specimens of beer examined the amount of arsenic in one gallon corresponded to much less than this quantity. Also an interesting point, on which much stress has been laid, is the statement made by so many patients in the Manchester epidemic that the amount of beer taken had not been great—three or four glasses of the cheap beer daily.

The amount of alcohol in the moderate quantity of beer taken by many of the patients would appear to be scarcely sufficient to cause neuritis. But, it may be asked, would the amount of arsenic in these smaller quantities of beer be sufficient to produce neuritis? Making allowance for under-estimation of the quantity, it appears that many of the sufferers did not take more than three or four pints of beer daily. In some of the most contaminated specimens the amount of arsenic in this quantity of beer would be alone sufficient to produce the neuritis. But in numerous specimens the amount of arsenic was small—from 0·14 to 0·3 grains per gallon (Professor Délepine's figures); and the amount in three pints would be equivalent to, from two to four minims of liquor arsenicalis three times a day; and the amount in four pints would be equivalent to, from about three to five minims of liquor arsenicalis three times a day. It has been pointed out by Sir Wm. Gowers and Dr. Buzzard that liquor arsenicalis can be taken medicinally, along with potassium bromide, for long periods by epileptic patients without neuritis being produced. Dr. R. W. Mackenna has shown that in cases treated with Donovan's solution for many months no neuritis is produced, although the amount of arsenic taken daily (as arsenious iodide) is greater than the largest estimate given by Professor Délepine and Mr. Kirkby of the arsenious oxide in one gallon of beer. Also many patients suffering from anæmia, leucocythæmia, and Hodgkin's disease are often treated for long periods with quantities of liquor arsenicalis, which contain more arsenic than appears to have been taken by many of the sufferers from neuritis in the recent epidemic (judging from the analyses published by Dr. Délepine and Mr. Kirkby), and yet no neuritis has been produced. Gastro-intestinal symptoms and pigmentation of the skin appear to be produced much more readily than neuritis by large doses of arsenic given medicinally.

But in medicinal doses the liquor arsenicalis is not associated with any other substance having a toxic effect on the peripheral nerves, whilst in arsenical beer it is associated with alcohol; and this probably explains the difference of action. The amount of alcohol in four pints of beer (for example) would be about equivalent to that in eight ounces of brandy. The action of this quantity of alcohol, combined with that of a small dose of arsenic, might well explain the toxic effect on the peripheral nerves, though the same quantity of each alone may be insufficient to produce bad results.

It appears to have been clearly proved that a *very large number of cases of peripheral neuritis in Manchester during the epidemic of* 1900 *can be attributed to the increased toxic action of beer owing to the presence of arsenic.*

In those cases in which *very large quantities* of beer have been taken, the amount of alcohol alone, and, in the more contaminated specimens, the amount of arsenic alone would be sufficient to account for the peripheral neuritis. Naturally the combination of the two would increase the toxic action of the beer. In the cases in which the quantity of beer consumed has not been great, probably the amount of arsenic present has sometimes been sufficient to produce neuritis, but in many cases, probably the quantity of arsenic taken has not exceeded what is often given for long periods medicinally without any neuritis being produced; but the combination of arsenic with alcohol has apparently caused the toxic action of the beer in such moderate quantities.

The importance of *combined toxic action* has been already recognised, with reference to alcoholic and other metallic or organic poisons, by Professor Oppenheim in 1891, and by Professor Remak. They have pointed out that a small dose of a poison, which we cannot regard as toxic, is able to produce multiple neuritis when the individual is also under the influence of a second poison.

Sir William Gower, Dr. Buzzard, Sir Lauder Brunton, and Dr. Luff have attached much importance to the combined toxic action in the Manchester epidemic (see discussion at the Medico-Chirurgical Society of London, January 8 and February 12, 1901).

Lead Paralysis.—This form of neuritis affects usually the arms only, and the symptoms are mainly motor. It is produced by lead poisoning in its various forms, but chiefly by chronic poisoning. It may be due to the presence of a minute quantity of lead in the drinking water. It occurs in painters, plumbers, type-setters, file-makers, potters, etc., who use lead or its salts in their work. It may be produced by the use of hair-dyes, etc. containing lead; or it may be due to lead-glaze of earthenware vessels.

Lead paralysis is often preceded by other symptoms of plumbism, such as colic and constipation; very rarely by pain in the muscles and joints; occasionally by anæmia or cachexia. Sometimes lead paralysis is the first indication of poisoning. Not infrequently the patient also presents signs of arterio-sclerosis or granular kidney, or he may suffer from attacks of gout. In pregnant woman abortion occurs. In lead paralysis a blue line is usually present on the gums, close to and between the teeth; it may be absent, however, if the teeth are kept very clean.

Lead paralysis usually affects both arms; one a little before the other, very rarely one only. The onset of the paralysis is somewhat gradual. In the common form of the disease the extensor communis digitorum is the muscle first affected. This causes dropping of the third and fourth fingers, and the patient is unable to extend them; whilst the index and little fingers can be extended since they possess additional extensor tendons—those of the extensor indicis and the extensor minimi digiti respectively. Soon these muscles are also paralysed and all the fingers are dropped. If the extensors of the wrist are not affected, then the hand can be extended at the wrist when the fingers are flexed. But often the extensors of the wrist become paralysed also, and then both the fingers and wrist are completely dropped, and the patient cannot extend either. The extensor muscles of the thumb phalanges (E. primi and E. secundi internodii pollicis) become paralysed, whilst the extensor ossis metacarpi pollicis is spared for a time at least. When the affection is well marked the dropping of the fingers is usually greatest towards the ulnar side, the little finger being most "dropped," the index finger least. The flexor muscles are not paralysed. The grasp is impaired, however, when the hand is in the dropped position; but when the hand is put into the extended position the grasp is good. The supinator longus is usually (but not invariably) unaffected.

The paralysis of muscles is *followed* by wasting, and the reaction of degeneration is found on electrical examination. Sometimes there is a swelling over the back of the hand near the wrist (Gubler's tumour) owing probably to thickening of the tendon sheaths of the long extensors of the fingers and to prominence of the carpal bones.

Usually only the muscles already mentioned are affected; but occasionally the thenar, hypothenar, and interossei muscles gradually become paralysed, and the paralysis is *accompanied* by wasting. In these muscles there is a diminution of the excitability to galvanism and faradism; and there may be a qualitative change to galvanism.

Occasionally another type of lead paralysis is met with in which the deltoid, biceps, brachialis anticus, and supinator longus are first paralysed.

The legs are generally unaffected and the knee-jerks present; in rare cases, however, the peronei and long extensors of the toes are affected, whilst the tibialis anticus is spared. In rare cases the psoas, iliacus, and quadriceps extensor have been affected.

Sensation is usually normal—pain, tenderness, and anæsthesia being usually absent; in the rare cases in which these symptoms have been recorded they have been very slight.

A fine tremor, increased by movements, is occasionally present in the hands. In rare cases paresis of the adductor and abductor muscles of the vocal cords has been detected.

Optic neuritis occasionally develops; it may be due to associated granular kidney, or it may form one of the changes in albuminuric retinitis; but in other cases the kidneys are unaffected. When optic neuritis is found the lead poisoning is usually acute; it is present when cerebral symptoms occur. Post-neuritic optic atrophy and amblyopia without ophthalmoscopic changes have been recorded in a few cases.

Cerebral symptoms are occasionally met with, such as apoplexy (due to hæmorrhage or softening), epileptic convulsions, and hysterical symptoms. A rare cerebral complication is "lead encephalopathy," which almost invariably terminates fatally. In this affection the patient suffers from convulsions; delirium occurs, and coma finally develops. The temperature is raised to 100 or 101, and double optic neuritis is present. In females this serious complication is often preceded by hysterical symptoms. In rare cases mental disturbances, mania, melancholia, and progressive mental failure, have been recorded.

Diagnosis.—Double-dropped wrist, due to bilateral paralysis of the extensor communis digitorum, *without affection of the legs and without sensory symptoms,* is generally due to lead poisoning. In the double-wrist drop in alcoholic or arsenical neuritis, pain, tenderness, and other sensory symptoms are usually very prominent, and the legs are also affected. The presence of a blue line on the gums is a most important indication of lead poisoning. A history of lead colic, and evidence of a source of lead poisoning, etc., are of much value in the diagnosis. The examination of the drinking-water or of the patient's urine for lead may be of service, though Dr. Dixon Mann has shown that the elimination of lead from the system is much greater by the bowels than by the kidneys.

Prognosis.—If the patient is seen at the early stage of the paralysis, and the introduction of the poison into the system at once stopped, recovery soon occurs; if seen at a later stage, recovery is more prolonged. Death may occur from associated granular kidney, or in rare cases from lead encephalopathy.

Pathological Anatomy.—The pathological changes in lead paralysis are most marked in the peripheral nerves of the arm, especially the posterior interosseous (radial) nerve. These changes are constantly found. They are most intense in the terminal intra-muscular branches, and gradually diminish towards the central end of the nerve fibres. In the larger nerve trunks they are much slighter; the cords of the brachial plexus, and the anterior nerve roots are generally, and posterior nerve roots always, unaffected.

The changes consist of a parenchymatous or degenerative neuritis, and the connective tissue between the nerve fibres is usually little affected; but occasionally an increase of the connective tissue of the epi-, peri-, and endo-neurium is found.

In some fibres, presenting the early change, there is degeneration of the myelin sheath, which is broken up into globules and small blocks: the nerve nuclei are more numerous, and the surrounding protoplasm is increased; but the axis cylinder is preserved. In other fibres, in addition to these changes the axis cylinder has degenerated also. Whilst in the fibres most affected there is complete degeneration and disappearance of myelin and axis cylinder, and the nerve sheath is empty, with the exception of the nerve nuclei at short intervals.

Gombault has described changes which he has been able to detect in guinea-pigs suffering from experimental chronic lead poisoning. In the early stages he found in the same nerve-fibre diseased segments separated by healthy segments. In the former segments the myelin was broken up into fine granules; the protoplasm around the nerve nuclei was increased and the nuclei proliferated, but the axis cylinder was unaffected. In other fibres the degenerated myelin globules were clustered into spindle-shaped swellings, which were separated from each other by naked axis cylinders. In the fibres most degenerated the myelin had entirely disappeared, and only the axis cylinders remained. Gombault distinguishes these changes from Wallerian degeneration—(1) by their discontinuity, diseased segments being separated by normal segments; (2) by the degeneration being limited to the myelin, whilst the axis cylinder is normal. To this form of degeneration he has given the name of "*névrite ségmentaire périaxile.*" But along with these changes usually fibres are found showing the true Wallerian degeneration. Gombault's periaxial neuritis is probably an early stage of Wallerian degeneration. It has been found in lead paralysis, alcoholic, diphtheritic, and puerperal neuritis.

The spinal cord is normal in most cases of lead paralysis. In a few cases atrophy of nerve-cells in the anterior horn of the cervical region, with disappearance of fine nerve-fibres in the anterior horn, has been recorded. But these changes in the nerve-cells of the anterior horns are very rare; when present they are usually slight, and the changes in the peripheral nerves are much more advanced.

(In a case examined by Laslett and Warrington, the nerve-cells of the anterior horns of the cervical region, at the level of the sixth and seventh segments, presented distinct changes when stained according to Nissl's methylene blue method. The nuclei of the cells were placed very eccentrically, and the Nissl bodies of the cell protoplasm were dispersed over the body of the cell in the form of fine powder. Often in the central mass of a cell an actual disappearance of the blue colouring matter was noticed, the result of a process of chromatolysis. The anterior nerve roots of the sixth and seventh segments showed atrophied fibres, and the posterior interosseous nerve was markedly degenerated. In the fourth and fifth segments of the cervical region, the cell changes were almost absent. The changes in the nerve-cells of the cord are regarded as secondary to the peripheral neuritis, and as the result of the altered state of functional activity following atrophy of the axons of these cells.)

The paralysed muscles are pale and atrophied markedly; in advanced cases they consist chiefly of connective and fibrous tissue, with remnants of muscle fibres. Microscopical examination shows that the muscle fibres are atrophied. The transverse striation is often preserved, but in advanced cases it may be lost. The muscle nuclei are proliferated. In advanced cases the sarcolemma sheath contains granules only, or it may be empty. The connective and adipose tissue between the muscle fibres is increased.

Whilst most observers regard the changes in the peripheral nerves as the primary affection in lead paralysis, Erb and Remak think that the peripheral neuritis is secondary to some functional change (as yet unrecognised) in the nerve-cells of the anterior horns.

MERCURIAL NEURITIS.—A small number of cases are on record in which multiple neuritis similar to alcoholic neuritis (especially the ataxic form) has developed in patients who were under mercurial treatment. The patients have often been syphilitic or alcoholic. In some of the cases it has not been possible to decide whether mercury, syphilis, or alcohol has caused the neuritis. In the case of Spitzer there was mercurial salivation and stomatitis, and the symptoms subsided when the mercury was discontinued. As mercury is used so often in medicine, and neuritis following its administration is so rare, Schultze suggests that the cases may be due to combined toxic action of mercury and alcohol. Several writers have pointed out that syphilitic polyneuritis is made worse by mercury.

DIPHTHERITIC NEURITIS.—This is the most common form of multiple neuritis following an infectious disease. It usually develops two or three weeks after diphtheria, and may follow either a mild or severe attack. In the most common form paralysis of the soft palate is the first symptom. As a result thereof the voice has a nasal twang, there is difficulty in swallowing, and fluids regurgitate through the nose: the soft palate hangs down at the back of the mouth, and is not raised on phonation. Usually the mucous membrane of the soft palate is anæsthetic, and the palate reflex cannot be obtained. In some cases no further symptoms develop, but in other cases the ocular, pharyngeal, or laryngeal muscles are also affected. There is inability to see small objects close to the eyes, such as small print, owing to loss of the power of accommodation from paralysis of the ciliary muscle. The pupils, however, are generally unaffected, and react both to light and when the patient attempts to accommodate. Occasionally the sixth nerve is paralysed on each side; very rarely other ocular muscles are paralysed. The muscles of the pharynx may become paralysed, and great difficulty in swallowing is caused thereby. The mucous membrane of the pharynx and larynx may become anæsthetic, and reflex movements connected with these parts may be lost. The muscle fibres which depress the epiglottis may become paralysed also. Owing to the three affections just mentioned food is very liable to find its way into the larynx and trachea. The recurrent laryngeal nerve is sometimes affected, and the muscles of one or both vocal cords are paralysed; the voice becomes hoarse and there is aphonia.

When one or more of these localised forms of paralysis are present the knee-jerks are usually absent; but there may be no other affection of the limbs. In most cases, however, other evidences of neuritis in the limbs develop, such as numbness and weakness. Often the paralysis of the palate has disappeared before the limbs are much affected. The weakness of the limbs increases, and passes on to complete paralysis. Frequently both arms and legs are affected, sometimes the legs only. The knee-jerks are absent, and sometimes the reaction of degeneration is obtained. In addition to numbness and tingling, anæsthesia may be present in the limbs; or there may be diminution of sensation to tactile impressions, diminished power of localising sensation and of telling the position of the limbs, whilst at the same time hyperalgesia is present.

In a small proportion of the cases the symptoms consist chiefly of numbness and tingling, with ataxia and unsteadiness in walking. In these cases the knee-jerks are absent, and hence they bear some resemblance to locomotor ataxia.

The bladder and rectum are not paralysed. The affection of the limbs usually does not reach its height for one to three months, and by this time the paralysis of the palate, ocular or laryngeal muscles has generally subsided.

In rare cases paresis or paralysis of the muscles of the face, neck, or trunk, or of the intercostals has been recorded. Sometimes the diaphragm becomes paralysed.

The localised paralysis usually disappears in a few weeks, but the severe generalised affection of the limbs generally does not disappear for three months or longer.

The prognosis is favourable when the affection is limited to localised paralysis of the palate or ocular muscles. In the severe forms the chief dangers consist of cardiac failure (? due to neuritis of the vagus); inability to swallow, and slow starvation; broncho-pneumonia through the entrance of food, etc., into the trachea; and paralysis of the diaphragm from neuritis of the phrenic nerve.

The *diagnosis* is easy if the paralytic symptoms follow a well-marked attack of diphtheria. But often the throat affection has been slight and its nature indefinite; in such cases the combination of paralysis of the palate and of the ciliary muscles, along with absent knee-jerks, is almost diagnostic. If the local paralyses of the palate or ocular muscles have disappeared the difference of the sensory symptoms in diphtheritic and alcoholic paralysis is of importance: in diphtheritic neuritis pain in the limbs and tenderness of the nerves and muscles are slight or absent; in alcoholic and arsenical neuritis, usually marked. The ataxic form differs from true tabes by its more rapid development, by the absence of shooting pain, and usually by the normal pupillary reactions.

Pathological Anatomy.—The most constant and important change is multiple neuritis in the peripheral nerves. The nerves in the neighbourhood of the diphtheritic process (soft palate and fauces) are first affected; they present marked neuritic changes. In the limbs the neuritic changes are most marked in the finest branches of the peripheral nerves, and the nearer the spinal cord the nerves are examined the less marked are the changes. The neuritis is sometimes of the degenerative or parenchymatous form. In other cases there is both parenchymatous and interstitial neuritis; the connective tissue between the nerve-fibres is increased, and occasionally, by œdema and inflammation of the connective tissue, small nodular swellings are produced. Microscopically these small swellings present infiltration of the connective tissue with numerous cells,—leucocytes and compound granular cells.

Not infrequently in the cranial nerves supplying the larynx and eye muscles neuritic changes are found. Changes have also been recorded in the cardiac and pharyngeal plexus.

Occasionally degeneration has been found in the anterior spinal nerve roots. In some cases the nerve-cells of the anterior horns of gray matter of the spinal cord are atrophied, and their processes diminished; also occasionally a proliferation of the neuroglia of this region with increase of its nuclei has been recorded. The paralysed muscles may show no definite changes microscopically, or degenerative atrophy may be found similar to that observed when muscle nerves are degenerated. In a few rare cases the muscular changes have been marked, and the interstitial connective tissue proliferated. No diphtheria bacilli can be found in the degenerated nerves, and it has been shown by the experiments of Roux and of Sidney Martin that paralysis and peripheral neuritis can be caused in animals by the injection of a toxin obtained from a cultivation of the diphtheria bacilli. There can be no doubt that a toxin produced by the diphtheria bacillus is the cause of the diphtheritic neuritis in man.

Puerperal Multiple Neuritis.—This is a very rare form of neuritis which may occur both during pregnancy and after delivery. It is not due to injury of nerves during parturition. It has been attributed to puerperal auto-intoxication. The diagnosis depends on the association of the neuritis with pregnancy or parturition, and the absence of alcoholism or other causes. (Turney admits that not infrequently alcohol and the puerperal state seem to co-operate.)

In the most common generalised form the symptoms correspond to those of alcoholic multiple neuritis. In a few of the cases optic neuritis has been also present. In a second form there is a localised polyneuritis of the upper or lower limbs with pains, nerve tenderness, paralysis, and muscular wasting. In the upper limbs the ulnar and median nerves are most affected; in the lower limbs the anterior crural and sciatic nerves. In a third form neuritis of a single nerve (ulnar or sciatic) is met with. In a few rare cases the symptoms have resembled those of Landry's paralysis. (An obstetrical neuritis, due to the traumatic injury of nerves in the pelvis during delivery has also been recorded.)

The pathological examination in a case reported by Korsakow and Serbski revealed parenchymatous neuritis in the peripheral nerves—most marked in the smallest branches. There were also changes in the lumbar and sacral plexus, and in several cranial nerves. There was an increase of neuroglia in Goll's columns and in the lateral columns of the spinal cord; otherwise the central nervous system was normal.

Diabetic Neuritis.—The knee-jerks are not infrequently absent in hospital patients suffering from a severe form of diabetes mellitus. In 100 hospital cases suffering from diabetes mellitus the writer found the knee-jerks both absent in 49, both present in 45, one absent and one present in 6. Amongst diabetic patients seen in private practice the knee-jerks are only absent in a small percentage. In thirty cases seen in private practice recently by the writer the knee-jerks were present in all.

The loss of the knee-jerks is probably due to changes in the peripheral nerves in most cases, and this has been verified by the pathological examination in several instances; but the writer has found the peripheral nerves normal microscopically when the knee-jerks have been absent.

In the late stages of the diabetes, and especially in diabetic coma, the knee-jerks are absent in most cases, but not in all (see article "Diabetes Mellitus.")

In addition to the loss of knee-jerks other symptoms, probably of neuritic origin, are sometimes present, such as frequent cramps in the calf muscles, gnawing pains in the legs, tenderness of the calf muscles, numbness and tingling, and feebleness of the legs. The calf muscles may be so tender on pressure, that the patient is unable to bear one leg upon the other in bed.

In rare cases actual paralysis of the legs, with dropped feet, and symptoms similar to those of alcoholic neuritis are present.

Occasionally perforating ulcers of the feet are met with, and usually they are associated with slight or well-marked indications of neuritis.

In a few cases pain, paresis, and neuritic symptoms have been observed in the distribution of the anterior crural and obturator nerves.

Rare forms of localised paresis or paralysis of single muscles (probably of neuritic origin) have also been described.

In a few cases, the clinical diagnosis of peripheral multiple diabetic neuritis has been confirmed by pathological examination.

The changes have usually been those of parenchymatous (degenerative) neuritis. (In a case recorded by Fraser and Bruce, segmental periaxial neuritis was found.)

In most of the cases of diabetic neuritis recorded the patients have been over the age of 50, and often the amount of sugar in the urine has been small. In severe forms of diabetes in younger patients (with abundant sugar excretion) well-marked neuritis is extremely rare. Hence diabetic neuritis is believed to be due, not to sugar, but to the presence of some other associated toxic substance in the system.

Other Forms of Neuritis.—Neuritis occasionally follows *influenza*. It may affect all four limbs, as in alcoholic neuritis; but this is rare. More commonly it is localised in certain groups of muscles or certain parts of one or two limbs.

There are other cases of neuritis in which no cause can be ascertained, so-called *idiopathic multiple neuritis*. In these cases the symptoms may resemble those of multiple neuritis from alcohol and other causes. In several cases of this form of neuritis double facial paralysis has been recorded; it was present in one of the writer's cases.

Many cases recorded as Landry's paralysis have probably been due to peripheral neuritis (see article on this disease, and monograph by Drs. Ross and Bury on peripheral neuritis).

(For description of neuritis in beri-beri and leprosy see articles on these diseases.)

The other forms of neuritis are too rare, and too closely resemble the forms already considered, to permit of separate description in this article. In the work of Dr. Ross and Dr. J. S. Bury, and in Remak's recent monograph, detailed accounts of these rare forms are given (see Bibliography).

TREATMENT of MULTIPLE NEURITIS.—The most important point as regards the treatment of multiple neuritis is to discover the cause, and, if it be some toxic substance entering the system daily, further chronic poisoning should be prevented.

In alcoholic neuritis all alcoholic beverages should be discontinued. Also in other forms of neuritis it is well to forbid alcohol, or to allow only a very small quantity in order that there may be no risk of "combined" toxic action. In neuritis from lead, arsenic, mercury, carbon disulphide, naphtha, carbon monoxide, dinitro-benzene, it may be necessary for the patient to change his occupation or to take special precautions to prevent the entrance of these poisons into the system. (In all cases of doubtful origin beer or alcoholic beverages taken by the patient should be examined for arsenic.)

Complete rest in bed is most important in all forms of neuritis (with the exception of lead neuritis). It is very desirable that careful attention should be paid to the feeding, and the patient should have an abundant quantity of suitable nutritious food. Milk, cream, eggs, fatty food and cod-liver oil are thought to be of much service.

In alcoholic neuritis it is often necessary to remove the patient to a hospital or nursing home in order to prevent the alcohol being continued. As tuberculosis so frequently occurs as a complication in alcoholic neuritis, it is most important that the patient's room should be well ventilated, and that all precautions should be taken to prevent the possibility of tubercular infection; also in view of this risk everything should be done to improve the general nutrition. In the early periods of the disease it is usually necessary to give drugs for the relief of pain, such as antipyrin, antifebrin, phenacetin, and salipyrin; cocaine or opium may be occasionally necessary. The limbs are sometimes more comfortable when surrounded by cotton-wool. For sleeplessness sulphonal, trional, or chloral-amide may be necessary; if there is also much excitement a small dose of hyoscine is often of service. If the heart's action is feeble small doses of digitalis are advisable. In the chronic stages of the disease tonics, such as quinine, strychnine, cod-liver oil, are indicated, and potassium iodide is thought to be of slight service by some writers.

A wire "cradle" should be placed over the feet to prevent the pressure of the bed-clothes, which would increase the foot-drop. Also it is important to keep the feet at right angles to the legs by the use of a sand-bag or foot-splint; in this way the dropping of the feet is rectified and permanent fixation of the feet in the position of talipes equino-varus is prevented. There is a great tendency for the legs to be flexed at the hips and knee, and to become permanently fixed in this position. Hence the legs should be kept extended as much as possible. After the acute stage has passed the daily stimulation of the paralysed muscle with the galvanic current tends to maintain their nutrition until the degenerated nerves recover. Massage is of service in the later period of the disease, the limbs being rubbed in an upward direction. Also passive movements at the various joints should be made. But massage should not be given when the limbs are very painful, and it should never be continued if it gives great pain.

These remarks on the treatment of alcoholic neuritis apply also to most of the other forms of neuritis. The following points may be mentioned in addition :—In lead neuritis potassium iodide is usually given, as it is supposed to increase the elimination of lead from the system. (This supposed action has, however, been recently disputed by Dr. Dixon Mann.) Oliver thinks that monosulphite of soda, gr. 5-10, three times a day, aids the elimination of lead. Aperients containing saline sulphates are thought to be of slight service also. Galvanism of the paralysed muscles, with massage, tends to keep up their nutrition until the degenerated nerve-fibres recover. An abundant nutritious diet, a pure atmosphere, open-air exercise, and warm baths are of service.

As regards diphtheritic neuritis, the antitoxin treatment of diphtheria has no effect in preventing its development. When there is difficulty in swallowing it is necessary to feed the patient with an œsophageal tube or by nutrient enemata. If there be any signs of cardiac failure the patient should not be allowed to sit up in bed, and digitalis or caffein may be given. When the breathing is difficult artificial respiration may be of service in carrying the patient through a period of temporary respiratory failure.

In malarial neuritis quinine should be given.

In arsenical neuritis potassium iodide is said to be of some service in removing arsenic from the system, and may be given if there are no signs of cardiac failure.

In diabetic neuritis the diet should be restricted according to the form of the disease (see article on "Diabetis Mellitus"). Sodium salicylate or antipyrin should be given.

In the puerperal neuritis occasionally it may be necessary to bring on labour artificially.

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Neuralgia

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The term neuralgia is applied to pain, usually paroxysmal in nature, which follows the course of a nerve or its branches, but which is not associated with gross or organic lesions of any part of the nervous system.

Etiology.—Neuralgia is a disease of adult life. Children rarely suffer. It is often associated with anæmia, occasionally with gout, diabetes, rheumatism, malaria, or an acute infectious disease such as typhoid fever. In females it is more liable to occur at puberty, during pregnancy and the puerperium and at the climacteric period.

Old age and arterio-sclerosis appear to predispose to one form of the disease.

Very frequently neuralgia is excited by exposure to cold, local or general, occasionally by emotional disturbances. Injuries to nerves may be followed by obstinate neuralgia.

Trigeminal neuralgia, especially that form affecting the first branch, may follow influenza, infectious diseases, or malaria; it may be associated with chronic catarrh, or new growth affecting the nasal mucous membrane, or with chronic catarrh or disease of the frontal sinus; occasionally it has followed a nasal operation. Trigeminal neuralgia may be excited by caries and other affections of the teeth, by disease of the alveolar processes of the jaws (both when the teeth are present and absent), by disease of the periosteum of the bony canals, through which branches of the fifth nerve pass; occasionally it is associated with diseases of the eye, with errors of refraction, diseases of the tongue and ear. Sometimes neuralgia is due to hysteria or neurasthenia. In many cases of severe neuralgia, especially of the epileptiform variety, no cause can be detected.

Symptoms.—The chief symptom of neuralgia is pain, paroxysmal in nature, in the distribution of one or more nerves. The duration of the pain may be very short (few seconds or minutes), or it may continue for an hour or more. There are intervals between the attacks in which the pain is absent or slight. During the attacks the pain is darting, stabbing, or boring in character; if pain be present between the attacks it is dull and aching. The pain often corresponds to the position of a nerve trunk. The attacks are frequently excited by cold, movements, food, and occasionally by emotions. Pain in one branch of a nerve may extend to other branches when severe, or even to adjacent nerves. Hyperæsthesia or hyperalgesia of the skin often accompanies the pain. A touch may be felt as pain or may excite neuralgic pain, but firm pressure may give relief. The pain is most intense at certain points; these spots are tender, and pressure upon them may induce a neuralgic attack (points of Valleix). Mostly they correspond to the place where a nerve trunk passes out of a bony canal, over a hard structure, or through a fascia. Occasionally there is tenderness of a vertebral spine corresponding to the nerve origin. Paralysis and persistent anæsthesia do not occur in true neuralgia. Occasionally muscular spasm accompanies, or transient anæsthesia follows a paroxysm.

Lachrymation, salivation, local sweating, local pallor followed by redness, may occur during an attack. Occasionally the hair becomes gray or falls off, and occasionally there is a slight local œdema after an attack.

At the height of a paroxysm the pulse may be slow, and in rare cases vomiting has been recorded. In cases of long duration the appetite is lost; general impairment of health and melancholia, with suicidal tendencies, may follow.

Several forms of neuralgia are recognised according to their causation:—Anæmic, which is frequently in the first division of the fifth, in the auriculo-temporal branch, or in the left infra-mammary region; gouty; diabetic, which often affects the third division of the fifth nerve, and is sometimes bilateral; malarial, which affects chiefly the first division of the fifth nerve, and which is periodic, occurring at intervals of one to four days; syphilitic; influenzal, which affects chiefly the first division of the fifth nerve; rheumatic; degenerative, which occurs in old age, and is very persistent; hysterical; traumatic; and herpetic.

Trigeminal neuralgia (neuralgia of the fifth nerve, tic douloureux) is the most common form of the disease. It may affect all three branches of the fifth nerve, but more commonly only one or two divisions suffer. It is nearly always unilateral (except in diabetes). Often it is very intense, and may then radiate from one branch of the nerve to the next or to an adjacent nerve. Cold, contact, and movement may excite an attack. Muscular spasm may occur in the face muscles when the pain is intense (tic convulsif). Flushing of the face, sweating, lachrymation, and increased flow of saliva and nasal mucus may be observed. Local grayness or loss of the hair and slight œdema of the face are occasional symptoms.

In neuralgia of the first division (supra-orbital), pain radiates from the supra-orbital notch over the anterior half of the head, and also into the eye, and eyelid, and down the side of the nose. Tender spots are detected just above the supra-orbital notch, in the upper eyelid, at the lower edge of the nasal bone, and sometimes in the eye-ball.

In neuralgia of the second division (infra-orbital), the pain is between the orbit and mouth. Tender spots are at the infra-orbital foramen, at the side of the nose, over the malar bone, and along the gums of the upper jaw. In neuralgia of the third division the pain often radiates widely: it may be felt in the lower jaw, tongue, parietal eminence, temple, and ear. Tender spots are over the inferior dental and mental foramina, just above the zygoma in front of the ear, over the parietal eminence, and in the tongue. Often separate branches of the fifth nerve are affected alone or chiefly, as the inferior dental, lingual, or auriculo-temporal.

Epileptiform Neuralgia (*Neuralgia Major*).—This is the most obstinate and severe form of trigeminal neuralgia. The disease begins in the second half of life, and no cause can be detected. At first the pain is of ordinary severity, but in time it becomes most intense; it always begins in the area of distribution of the fifth nerve. Sometimes convulsive spasm of the facial muscles accompanies the pain. The attacks last for a second or two, or for a minute or more. They are often repeated frequently; sometimes fifty or a hundred attacks occur daily. Cold, emotions, movement of the face, and even defæcation may bring on an attack. The patient often tries to relieve the pain by rubbing the face. Teeth are often removed without avail. Sleep is frequently impossible without the use of drugs. Food is taken with difficulty, and the general health in time becomes impaired.

Cervico-occipital neuralgia is rare; it involves the posterior branches of the four upper cervical nerves, especially the great occipital nerve. There are tender points midway between the mastoid process and the first cervical vertebra and between the sterno-mastoid and trapezius. The pain is less violent than in trigeminal neuralgia.

Brachial neuralgia and neuralgia of the phrenic nerve are described in the articles on the "Brachial Plexus" and on the "Diaphragm," vol. ii.

Intercostal neuralgia is often due to cold; it also occurs in hysteria and anæmia. In the latter condition it is chiefly left-sided and in the infra-mammary region. Tender points are near the vertebra, near the third mid-axillary line, and near the middle line in front. (See also Mastodynia, art. "Mammary Gland," vol. vii.)

In *lumbo-abdominal neuralgia* the pain is in the lumbar region, lower part of abdomen, and groin. Tender points are over the middle of the iliac crest, in the hypogastrium, scrotum (or labia). Occasionally the neuralgia follows the distribution of the crural nerve in the thigh. Both these forms of pain are frequently secondary to organic disease, and not truly neuralgic.

For description of other forms of neuralgia see articles on "Coccygodynia," "Sciatica," "Erythromelalgia" (Raynaud's disease), "Metatarsalgia," and "Visceral Neuralgia" associated with various organs.

Pathology.—Nothing definite is known as to the pathology of neuralgia; but there are several points (the radiation of pain into adjacent nerve regions during an attack, and the reflex character of the pain in certain cases) which favour the view that the seat of the disease is in sensory cerebral or spinal nerve-cells. Oppenheim thinks that it is probable that it may be caused by fine nutritional changes in the nerve, in its sheath, and in the nervi nervorum. Even in cases of many years' duration microscopical examination has revealed nothing. In a few cases of trigeminal neuralgia slight vascular, sclerotic, and degenerative changes have been found in the nerve-fibres or in the Gasserian ganglion, but in other cases the cells of this ganglion (examined by Nissl's method) have been normal. The importance of these slight changes is very doubtful.

Dana has recorded endarteritis of the vessels of the nerve sheath; Putnam endarteritis and sclerosis of the endoneurium; Horsley, Rose, Krause, Saenger, sclerotic changes in the Gasserian ganglion with degenerative changes in its cells and fibres.

Diagnosis.—Important points in the diagnosis of neuralgia are the migratory and intermittent character of the pain, and the absence of evidence of any organic lesion of the nerves or central nervous system, even in cases of long duration. Except in diabetic patients bilateral pain is very rarely due to neuralgia. In neuritis the pain is usually continuous, though exacerbations occur; swelling of the nerve can often be felt; soon anæsthesia and paresis, or paralysis with atrophy, develop. In neuralgia the pain occurs in paroxysms; no swelling of the nerve can be felt; anæsthesia and paralysis do not develop. If the nerve can be palpated, the whole or a large portion of it is tender from the first in neuritis. In neuralgia tender points may be found, but at first the nerve trunk is not tender between the attacks.

Careful general examination of the patient for indications of organic nervous diseases or of hysteria is most important.

Pain of a neuralgic character is often due to the pressure of a tumour on a nerve or nerve root, or to implication of nerves in other diseased processes. Such secondary neuralgic pain may be produced in the limbs by tabes, or other organic diseases of the spinal cord or spinal nerves; in the head by cerebral tumour, aneurysm, etc. at the base of the skull, implicating the fifth nerve. But usually other symptoms can be detected which show that the neuralgic pain is secondary, and that the case ought not to be regarded as one of true neuralgia. Visceral referred pain is distinguished, according to Head, by the presence of pain over areas not corresponding to those of definite peripheral nerves and by the presence of tenderness of superficial structures.

It is always important to inquire carefully into the etiology of all cases of neuralgia in order to obtain indications for treatment.

Prognosis.—In some cases (minor form) the disease continues for a short period only: in others (major form) it may continue for many years. The disease does not directly cause death. The prognosis is worse the older the patient, the longer the duration of the affection, and the less it is related to any of the well-recognised causes of the disease. The epileptiform variety of trigeminal neuralgia is of all forms the most obstinate and difficult to relieve.

Medical Treatment.—When neuralgia is clearly *secondary* to another affection, treatment should be directed to the primary disease. When the teeth are diseased, and an attack of neuralgic pain is brought on by touching them it may be desirable to have one or more teeth removed. But it is to be remembered, that though benefit is sometimes derived thereby, on the other hand often no improvement follows. The treatment of associated diseases of the frontal sinus or nasal mucous membrane sometimes has a beneficial effect on the neuralgia.

When severe anæmia or chlorosis is present iron should be given, and the addition of arsenic is of service. In neuralgia associated with malaria quinine is indicated; in rheumatic cases, sodium salicylate; in syphilitic patients benefit is often derived from mercury and iodides; and in gouty patients treatment directed to primary disease is advisable. A suitable diet should be given when neuralgia is associated with diabetes; sodium salicylate is worthy of a trial. Very often there is no clear indication of a primary affection to which the neuralgia is secondary.

General treatment should not be neglected. The food should be nutritious and abundant; a mixed diet is best. Benefit has been derived by discontinuing a strictly vegetarian diet. When the patient is thin, fatty food, butter, cream, cod-liver oil are of service. The bowels should be kept regular, if necessary, by mild purgatives. The relief of constipation has occasionally diminished the pain. In some cases rest is of great service; in other cases, when the patient's occupation has been sedentary, life in the open air as much as possible is beneficial.

Innumerable *drugs* have been given *internally*, mostly with the object of relieving pain. When the pain is repeatedly relieved it often disappears entirely. Butyl chloral hydrate is one of the most valuable drugs we possess for the relief of trigeminal neuralgia. It may be given in 5 or 10 grain doses, dissolved in 20 to 40 minims of glycerine, and water or orange-flower water afterwards added to one ounce. Yeo recommends gr. 5 every hour for four doses, to be discontinued if no relief follows.

Tincture of gelsemium is of much service in some cases; but large doses are often required, and as such frequently produce slight toxic symptoms, and as the strength of the different preparations varies, considerable caution is necessary in using the drug.

Quinine in large doses is of distinct value, especially in supra-orbital neuralgia, even when there is no connection with malaria. Aconite is of service in facial neuralgia, but is liable to produce toxic symptoms. Sometimes large doses of potassium iodide are beneficial when there is no evidence of syphilis. Occasionally phosphorus, antipyrin, antifebrin, exalgin, and phenacetin have given relief. Oppenheim and others have found pyramidon distinctly useful.

In the neuralgia of old age nitro-glycerine may be given, and recently hypodermic injections of nitrate of strychnine (in increasing doses) have been recommended strongly.

When all other methods fail it may be necessary to give morphia hypodermically. At first the dose should be small—$\frac{1}{10}$ to $\frac{1}{8}$ or $\frac{1}{6}$ of a grain; and it is well to combine it with $\frac{1}{200}$ of a grain of atropine. The risk of forming a morphia habit should not be forgotten.

Locally, the fluid formed by rubbing together equal parts of chloral hydrate and camphor (or 3 of camphor, 3 of chloral hydrate, and 1 of menthol) often gives much relief. Solid menthol may be gently rubbed over the skin at the painful parts. Other useful local applications are chloroform liniment; or a liniment composed of menthol 3, chloroform 4, olive oil to 16; extract of belladonna and glycerine; cocaine and vaseline (1 in 20 or 30); aconite and veratria ointments (the last two should not be applied over any broken surface or mucous membrane). A few drops of a weak solution of cocaine dropped on to the conjunctiva, or the painting of the nasal mucous membrane with cocaine solution (5 to 10 per cent) may give relief to the pain (Oppenheim). The application of heat by a coil of small india-rubber tubing through which a stream of hot water is allowed to flow is sometimes of service (Collins).

Galvanism is occasionally beneficial. The anode pole is placed over the painful area, and the kathode on some indifferent part. A weak current (about 2 milliampères) should be used. The application should be continuous for about 5 or 10 minutes. A wet sponge may be used as an electrode, and this should be applied very gently and gradually; also it should be very gradually removed, so as to avoid a sudden make or break of the current, but a rheostat is better for this purpose. The electrical treatment should be given daily.

In some obstinate cases the introduction of cocaine into the tissues in the region of the affected nerve, by means of cataphoresis, has been of service. In very chronic cases the injection of a weak solution of osmic acid near or into the nerve has sometimes been most useful. Bennett recommends that the nerve (supra- or infra-orbital or mental) should be exposed by a very small incision, and the osmic acid solution injected by a sterilised hypodermic needle directly into the nerve substance. Injections of dilute solutions of carbolic acid or of cocaine hydrochlorate in the neighbourhood of the nerve have also sometimes given relief.

The Surgical Treatment of neuralgia is, in the absence of a thorough knowledge of its causation and pathology, necessarily empirical and not very satisfactory in its results. Hence all reasonable non-operative measures should first be tried, and especially such general conditions as anæmia and hysteria should be medically dealt with. In hysterical cases operation may cure by suggestion, but the probabilities are in favour of the recurrence of hysterical troubles, often of increased severity, in some other region. On the other hand, neuralgias due to painful cicatrices and to pressure lesions of nerves call for immediate surgical treatment, and such treatment can alone be of service; but with cases of this class we are not at present further concerned.

The operative measures open to us for the relief of neuralgia are five in number, viz.: (1) Nerve section or neurotomy, (2) Nerve resection or neurectomy, (3) Nerve stretching, (4) Avulsion of nerves, and (5) The excision of the cranial ganglia or resection of the posterior spinal roots.

Mere *section* of the affected nerve is practically useless. In all such cases regeneration ensues at an early date, and with it the original pain usually recurs.

Neurectomy, or the excision of a segment of the affected trunk, produces anæsthesia of more prolonged duration, and, as it is not a more formidable operation than section, it should in all cases be preferred. The method can only be adopted in the case of purely sensory nerves, and is hence almost limited in its application to the branches of the trigeminal and to the posterior spinal roots; resection of a mixed nerve presents too great a danger of leaving permanent paralysis. Except in special cases, to which we shall again refer, the operation is of the simplest nature, and consists in exposure of the affected trunk, which is picked up by a strabismus hook, aneurysm needle, or other blunt instrument, when a length of from half an inch to an inch can be cut away with scissors.

Nerve stretching has the advantage over neurectomy that it is applicable to nerves containing motor fibres. It induces primary symptoms of partial paralysis and anæsthesia similar to those of section, but is accompanied by far less risk of permanent paralysis, and it has certain special effects upon the whole length of the stretched cord and upon the central nervous organs. The nerve to be operated upon is exposed as in neurectomy, and is then hooked up by a blunt hook, or, if large enough, by the surgeon's fingers, which form the best instrument for the purpose. Should an Esmarch's bandage be employed to assist in the discovery of the trunk it should now be removed, so as not to anchor its upper portion. Stretching is effected by a series of steady pulls made alternately upon each end of the nerve so as to drag upon its peripheral and central connections. The amount of force which can thus be used without rupture of the trunk is considerable, and will in practice be determined by the *tactus eruditus* of the operator rather than by the standards which have been determined. Such force should fall far below the breaking strain of the nerve, and as a rough guide we may note the following as the estimated breaking strains of certain trunks: sciatic, 100 to 160 lbs.; musculo-spiral, 80 lbs.; median, 60 lbs.; infra-orbital, 10 lbs.; supra-trochlear, 5 lbs.

Avulsion of nerves appears to combine the advantages of neurectomy with those of nerve stretching, but is, like the former, applicable only to sensory trunks; for the branches of the trigeminal it is certainly to be preferred to any other method. The affected nerve is exposed and picked up in the usual manner; it may then be firmly clamped with a pair of hæmostatic forceps and drawn upwards so as to make firm traction on its peripheral ends; the latter are cut across as low as possible. This having been done, the nerve trunk is drawn downwards, dissected out from its connections for some distance, and finally wrenched away from its central end.

The *removal of the cranial ganglia* will be considered in connection with the treatment of trigeminal neuralgia. *Resection of the posterior spinal roots* was first advocated by Bennett in England and by Abbé in America, and has been found useful in a few cases of severe neuralgia of the brachial and lumbo-sacral plexuses. It aims at curing the disease by allowing resection to be performed without interference with the essential motor roots, but as it is a severe operation it should not be undertaken until all other measures, including nerve stretching, have failed. Laminectomy having been performed the dura mater is laid open, and the posterior spinal roots are picked up and divided. The root with its ganglion may be entirely resected, which would give a greater certainty of cure of the neuralgia, but would probably leave a permanent anæsthesia.

The means by which these various operations may be expected to cure neuralgia are as yet ill-defined. It is clear that such neuralgia may conceivably arise from lesions of the peripheral nerve endings, of the trunks themselves, or of the central organs. Were the first a common condition the division of the afferent tracts would certainly arrest the pain, and might be expected to prove permanently curative if regeneration were not associated with reattachment to the original peripheral terminations. Similarly, if the essential pathological lesion were in the nerve trunk its division above the level of that lesion would prove effective. There is, however, little reason to suppose that the pathological basis of neuralgia is thus situated

—or, at least, that it long remains thus circumscribed,—and it is probable that in all cases central or ganglionic structures are concerned. The value of operations upon peripheral nerves thus becomes obscure. Certain factors in the problem are, however, fairly demonstrated. In the first place, wherever the lesion may be situated an afferent impulse appears necessary to evoke pain, and if that lesion be central we must suppose that all impulses are as it were translated into pain, but that some form of external stimulation is none the less a necessary element in the production of such pain. Nerve section unquestionably arrests all afferent impulses, and therewith arrests pain. For permanent cure it is, however, necessary to affect also the central organs, and it is supposed that the operation does so either negatively by providing a period of complete rest from stimulation, or positively by producing some concurrent central change. That central changes in the minute anatomy of the nerve cells do follow nerve section is now proved, and it can hardly be doubted that important physiological results follow such operations, and that they are productive of more than mere rest.

Nerve stretching and *a fortiori* nerve avulsion are of more marked effect than mere section or excision. In the first place, the two former operations act upon branches which arise above the seat of traction, and thus the whole of a nerve trunk, including the very highest of its branches, may be temporarily thrown out of action by a stretching operation performed comparatively low down in its course. Changes in the stretched nerve are extensive, and include loosening of the sheath, tearing of its blood-vessels, congestion and slight inflammatory exudation, tearing of the nerve tubules, and degeneration followed by regeneration of those structures. Probably, also, sensitive nervi nervorum and their intra-neural terminations are paralysed by this method (Marshall and Horsley), and again adhesions due to perineuritis will obviously be broken down. Lastly, the associated central organs have been found to present congestions and hæmorrhages, while marked alterations occur in the nutrition of the ganglion cells.

It is difficult, if not impossible, to estimate the actual value of these various operations, especially in view of their comparative rarity in trunks other than the trigeminal, and of the different conditions for which they are performed. To the trigeminal nerve we shall again refer: with regard to all other cases we can only consider operation as tentative, and we can never be justified in promising permanent relief. Broadly speaking, Marshall estimates that 74 per cent of all cases of neuralgia are curable by operation.

The *method of operation* to be adopted in the case of individual nerves must be briefly dealt with.

The *brachial plexus* is exposed by an incision similar to that employed for ligature of the subclavian artery: its cords lie above that vessel, with the exception of the lowest cord which lies behind it: they can be readily isolated by blunt dissection, and then submitted, individually or collectively, to traction by the fingers, which should not exceed a pull of twenty pounds. It is to be remembered that in this region too vigorous a stretching may tear the nerve roots away from the spinal cord, their connection with which is less strong than is their inherent tenacity.

The *musculo-spiral* nerve is readily exposed to the outer side of the lower end of the humerus. The incision lies immediately internal to the upper part of the belly of the supinator longus, and divides the deep fascia, avoiding the cephalic vein. The supinator longus and radial extensors are now drawn well outwards when the nerve is found lying deeply between the supinator longus and the brachialis anticus.

The *median nerve* is exposed at the wrist by a vertical incision immediately external to the palmaris longus tendon: its accompanying artery is apt to be divided along with the nerve, and, if ligatured, care must be taken to avoid inclusion of any nerve fibres in the loop. The same nerve can be reached in the middle of the upper arm where it crosses the brachial artery.

For the *radial nerve* a vertical incision may be made internally to the lower end of the tendon of the supinator radii longus: the nerve here lies close to, or rather beneath, the tendon, and well away from the radial artery. It can also be readily found on the back of the wrist after its emergence from beneath the supinator longus tendon.

The *ulnar nerve* lies close to the inner side of the ulnar artery at the wrist, and is exposed by an operation similar to that employed for ligature of the vessel. At the elbow it is readily found behind the internal condyle where it can be felt through the unbroken skin.

The *great sciatic nerve* is exposed in the upper part of the thigh by a vertical incision, commencing below the folds of the buttock, and lying between the great trochanter and the ischial tuberosity, but half an inch nearer to the latter; the biceps muscle is drawn inwards, and the nerve found lying beneath it; the finger forms the best hook for stretching purposes, and a pull of 30 or 40 pounds may be employed. The sciatic nerve can, however, be conveniently stretched by the *bloodless method:* in this case, the patient being fully anæsthetised, the hip is forcibly flexed, the knee extended, the ankle dorsiflexed, and the toes extended: this forced position is maintained for some ten minutes, during which time the course of the nerve is thoroughly kneaded: the only danger of the operation lies in the possibility of injury to an atheromatous popliteal artery.

Trigeminal Neuralgia.—The general principles of the treatment of neuralgia are applicable to the trigeminal as to other nerves. Special consideration is required both because the branches of the fifth cranial nerve are operated upon far more frequently than are all other trunks, and because the fact that these branches are almost entirely sensory, allows to the surgeon a latitude which he does not possess elsewhere.

The cases most suitable for operation are those of true neuralgia, in which no extraneous cause for pain can be discovered, and thus hysterical and anæmic patients, the sufferers from gout, malaria, syphilis, and rheumatism, and those with visceral diseases which may produce reflex pains, should generally be excluded. Many cases originate in some local disease, such as a carious tooth, but become persistent even after removal of the cause. Operations upon the nerves are then often called for and are of value. In others, again, no cause is discoverable, but in these, and especially in the rare type of epileptiform neuralgia, operation should certainly be adopted if medical treatment has failed to relieve.

The operation to be selected will depend upon the nature of the case. Simple nerve section is almost valueless. Excision of a portion of the fibres and stretching have strong advocates. Avulsion combines the advantages of both methods, and is therefore strongly recommended for all cases other than those in which the Gasserian ganglion must be excised. Avulsion should be combined with removal of any suspected source of primary irritation. In a very large number of cases it will appear that the disease has originated in dental caries, inflammation around a buried tooth stump, or other cause of alveolar ostitis. In many of these the removal of the primary focus will cure the neuralgia, but in many others it will not. We have thus a double factor the initiating alveolar disease and the secondary central nervous changes. It is usually advised to treat the former only, and operate upon the afferent nerve later if cure is not effected; but in severe cases it is safer to perform both operations simultaneously, the nerve being avulsed, and any suspicious segment of the jaw removed at the same time. This radical method involves no serious surgical interference, and has the advantage of excising the peripheral focus at the precise moment in which it is cut off from the central nervous system, so that there is the less risk of interference with the physiological rest of the latter by the vicarious connections of the former.

Excision of the Gasserian ganglion is a serious operation, with a mortality of at least 10 per cent, and is therefore only to be undertaken in the most desperate cases. It is called for in persistent neuralgia after failure of the simpler operations, and in cases of severe epileptiform neuralgia.

We have now to consider the various operations adapted to dealing with the different branches of the trigeminal nerve.

The *supra-orbital nerve* passes through a notch or foramen at the junction of the inner and middle thirds of the supraciliary ridge, and its position can usually be determined by feeling for the small bony indentation. From this point the greater part of the nerve turns up on to the forehead, where it immediately divides into branches. The eyebrow being shaved, a horizontal incision is made immediately beneath it, and is carried through the orbicularis palpebrarum. Bleeding having been arrested by pressure, the notch with its nerve and artery are usually readily identified. The nerve is cleaned, and special care is necessary to ascertain that the whole of it is taken up on the hook, as two or more branches often lie side by side. The trunk being then drawn out by hæmostatic forceps, the peripheral branches are dissected out and cut off for as great a length as possible. Fine fibrous connections of the nerve to the pericranium should then be divided with the knife, and finally the trunk can be drawn out, often for an inch or more. The slight wound presents no difficulties, and heals readily.

The *supratrochlear nerve* lies parallel with the supra-orbital nerve, but about a quarter of an inch nearer to the nose. It is reached by the same incision as that used for its larger companion, and these two branches should always be dealt with simultaneously.

The *infra-orbital nerve* enters the cheek by the infra-orbital foramen, between a quarter and half an inch below the orbital margin, and on a line drawn from the supra-orbital foramen to the interval between the two upper bicuspid teeth. It is here exposed by a horizontal incision carried deeply through the soft structures of the face. At the bottom of this incision the foramen is most readily detected by the end of a probe, and the nerve is found issuing from it and at once breaking up into branches. All the branches should be caught up together, avulsion being performed in the usual way. Avulsion rather than section is here specially valuable, as the important dental branches of the nerve arise above the seat of operation. It has the incidental advantage of preventing bleeding should the artery be inadvertently seized with the nerve.

The above operation has the disadvantage of attacking the nerve below the origin of its principal branches, and hence other and more complicated procedures are generally advisable. An incision may be made along the floor of the orbit through which the eyeball is turned up, together with all the orbital fat and the periosteum. The roof of the infra-orbital canal is now broken open and the nerve traced back as far as possible (Horsley). This operation fails, as does the facial method, to reach the posterior dental branches and Meckel's ganglion.

Meckel's ganglion can be reached by the operation of Carnochan, or by the Braun-Lossen method. The former gives a very small area for manipulation, and by opening the antrum increases the dangers of septic infection, but both of these operations will be described.

(1) In Carnochan's, or the antral method, a Y-shaped incision is made with its centre on the infra-orbital foramen and its lower limb opening into the mouth. The soft parts and periosteum are well retracted. The antrum is opened by a ½-inch trephine and its posterior wall perforated by a ¼-inch trephine. The infra-orbital canal is opened from the antrum by careful chiselling. The nerve is thus laid bare, and can now be followed back to the foramen rotundum and there cut away with scissors. Meckel's ganglion is not always seen, but generally comes away with the nerve. Bleeding is very free, and requires prolonged sponge pressure or plugging of the wound.

(2) The Braun-Lossen or pterygoid method is free from some of the disadvantages of the above. A curved incision is made from the external angle of the frontal bone along the upper margin of the zygoma, and thence downwards to the angle of the lower jaw; in its lower part this incision must not extend beyond the superficial structures, and should not divide the facial nerve. The zygoma is then cleared by a horizontal incision through its periosteum, is sawn through before and behind, and is turned down with the masseter muscle. The mouth being slightly opened the temporal tendon is drawn well back or partially divided, and the pterygo-maxillary fossa is exposed. The internal maxil-

lary artery is ligatured and divided as it crosses the external pterygoid muscle. Following the upper border of this muscle the foramen rotundum is now reached, and the second division of the trigeminal nerve there exposed. If the nerve be now divided at the infra-orbital foramen, its entire length can be drawn out by traction at its posterior point of exposure. Meckel's ganglion is avulsed with the nerve to the under aspect of which it is attached in front of the foramen rotundum. The zygoma is now replaced and retained in position by sutures passed through the masseter muscle and adjacent soft parts at each end of the hiatus ; it is not necessary to suture the bone itself, and time is saved by avoiding the necessity for drilling it. The disfigurement produced by the operation is exceedingly slight.

The *inferior dental* nerve is readily exposed at the mental foramen which lies midway between the upper and lower borders of the lower jaw, in a line passing from the supra-orbital foramen between the bicuspid teeth of the upper jaw ; avulsion may here be performed, but is of little value, as the seat of operation is anterior to the dental branches. A more satisfactory method is to make a curved incision around the angle of the jaw, turn forwards the soft parts, and apply a half-inch trephine over the middle of the lower part of the descending ramus ; the trephine is carried well into, but not through the bone, when the dental canal is laid open, and the nerve exposed therein. The nerve can also be divided at either the mental or dental foramen from within the mouth, but the operation is less precise and cannot be aseptic. Still another method consists in working up inside the jaw from an incision made below it until the entrance of the dental canal is reached ; of this we have no experience.

The *lingual nerve* is more often divided to relieve the pain of epithelioma of the tongue than to combat a true neuralgia ; it lies in a line running from the last molar tooth to the angle of the jaw, and can there be felt and cut.

The *third division of the trigeminal nerve* may be divided in its entirety at its exit from the foramen ovale, this operation giving better results than separate treatment of the inferior dental or lingual. For this purpose the writer has found convenient a method similar to Lossen and Braun's operation upon the superior maxillary division : the zygoma being turned down with the masseter, the coronoid process of the lower jaw is cut away, and turned upwards with the insertion of the temporal muscle ; in this way the external pterygoid is clearly seen, and the branches of the inferior maxillary division escaping from beneath it can be traced back to the foramen ovale. As in other cases bony union of the parts cut through can be obtained by suturing their overlying soft structures, and drilling of the bone is not required.

The operation advised by Horsley and Rose, consists in making an incision similar to that of the Braun and Lossen operation, cutting across the masseter immediately below the socia parotidis, clearing the ascending ramus of the lower jaw, and making a large hole in it by the trephine and cutting forceps. By this means the structures of the face are injured less than in the first operation, but comparatively little room is provided for the deeper stages, and experience has shown that the first method leaves no practical deformity or inconvenience.

Removal of the *Gasserian ganglion* is indicated in cases in which the above operations have failed to cure, in cases of neuralgia involving the whole of the trigeminal area, and especially in epileptiform cases accompanied by secretory and vasomotor symptoms. The principal methods are those of Hartley and Krause, and of Rose, the former being preferred by most surgeons.

1. *The Hartley-Krause Operation.*—A horse-shoe-shaped incision is made in the temporal region, one end being immediately in front of the ear, and the other about an inch behind the outer angle of the orbit. This incision marks out a large flap with its base on the zygoma, and with a vertical depth of three inches ; it is carried down to the temporal fossa, and the cranium is there divided in the line of the cut by a circular saw or chisel. The combined flap of bone and soft structures is now turned down, and bleeding arrested by ordinary means. The dura mater covering the temporo-sphenoidal lobe is exposed, and is held back by a spatula ; in thus drawing back the dura mater, the second and third divisions of the trigeminal are indicated by its attachment along their course. They are cleared by blunt dissection, and traced back to the ganglion, which is similarly cleared. The ganglion is then grasped in a pair of forceps, its superior and inferior maxillary branches are cut across, and it is itself torn away.

Horsley's earlier operation was similar to that of Krause and Hartley, but opened the dura mater over the temporo-sphenoidal lobe, and again opened the dural sheath of the Gasserian ganglion from its inner or cerebral aspect instead of from its outer or cranial side.

2. *Rose's Operation.*—"An incision similar to that for exposing the foramen ovule (Braun-Lossen's) is made through the skin, and the flap thus marked out is drawn forwards and stitched out of the way. The zygoma is drilled and turned down together with the masseter; the coronoid process is then divided or removed, and, together with the temporal muscle, turned upwards; the internal maxillary artery is, if possible, secured, and the sphenoidal attachment of the external pterygoid scraped away so as to allow of the exposure of the foramen ovale, which lies just in front of the base of the pterygoid processes. A ½-inch trephine is now applied immediately outside the foramen ovale, and the bone around the opening thus made is also removed by forceps or chisel so as to give more space. The trunk of the third division is traced upwards, the sheaths of the ganglion opened, the second division cut through by means of a sharp cutting hook, and the ganglion torn away piecemeal, or at any rate broken up." Doyen's method is closely similar to Rose's, and hardly calls for description. All of these operations require considerable dexterity and good electrical illumination.

Operations upon the Gasserian ganglion are liable to be followed by destructive keratitis and loss of the eye, but it appears to be conclusively proved that removal of the ganglion alone does not cause such results in the absence of any sepsis or of local irritation of the eye, while all risks disappear within a week or two of the operation. Hence before operation the conjunctival sac should be carefully cleansed for a day or two by washing with a sterile solution of boracic acid, and the eyelids should be lightly sutured together, and kept carefully covered during the operation and for some days afterwards.

Lastly, ligature of the carotid artery has occasionally been practised for the relief of facial tic, and although now fallen into disuse, it appears to have been by no means inefficacious.

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Nervous System.—GENERAL INDEX.

The following is a note of the leading articles. *See also* General Index under PARALYSIS:—

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Aphasia.
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Nettle Rash. *See* URTICARIA.

Neuralgia. *See* NERVES.

Neurasthenia.—Neurasthenia means debility of the nerves. It has been described under the names, "General debility," "Spinal irritation," "L'état nerveux," "The vapours," "Nervous exhaustion," etc. We owe to Beard of New York the best modern description of the condition, and the name Neurasthenia, which is convenient and accurate, as it directs attention specially to the true source of the symptoms. What precisely is the significance of the phrase "nervous debility"? In neurasthenia, as in all other conditions of nervous breakdown, we have two etiological factors, diminished resistance (bad heredity) and increased strain (acquired during the life of the organism). This holds as clearly for neurasthenia, in which we must believe that the lower nervous layers are affected, as it does for insanity, where the pathological process affects the highest layers. In both cases the condition shows itself by altered conduct and deranged mentation, using these terms in their broadest sense. We will begin by discussing the problem of acquired neurasthenia due to strain, which strain may be direct or indirect.

The etiology is less complex in cases where a direct physical cause can be traced, many of which cases are called traumatic. In these we have a condition comparable to cases of insanity due to direct stress, a blow on the head, a sunstroke, the delirium of fever. No nervous system is so constituted as to be able to bear unlimited direct stress. Every beam has a breaking weight. One person may become neurasthenic as the effect of an upturn from a pony cart; another only as the result of a railway smash or shipwreck, accompanied or not by bodily injury and great privation. All gradations are included under the term traumatic neurasthenia. The problem of nervous debility is there presented in its least complex clinical form. The debility is due in all these cases directly to an injury or to the fear of an injury. For it is certain that what we call traumatic neurasthenia may arise as the result of fright without any bodily or recognisable injury having been received. It is not the broken arm or leg resulting from a railway collision, or even the jar and shaking experienced, that causes the victim to be a nervous wreck for months or years afterwards, but the general disturbance to the nutrition of his nerves caused by the accident itself, apart from his special personal share in its effects. It is quite possible to be much and for long the worse for a railway accident in spite of coming out of it apparently uninjured. As examples of this the following cases may be cited;—1. A gentleman was travelling in an express train from Aberdeen to London when the train went off the line. The carriage was hurled from side to side of the line but not upset. The traveller steadied himself with feet and hands as much as he could, received no blow, and thought he was perfectly calm and collected all the time. By good fortune the couplings broke and the carriage came to a standstill. The traveller descended and wondered to see his fellow-passengers crying and embracing each other in an hysterical manner. The cigar which he had kept in his mouth was still alight, and he finished it. Four hours of a summer night were passed in a turnip field till the relief train carried him on to York and London. To his surprise he found himself in a state of constant and increasing nervous distress during the journey, and for months afterwards he could not endure an express train; he had to go by the slowest possible, and even these tried him more than he liked to admit. It was at least a year before the effect of the fright left him. 2. An elderly gentleman, Mr. B., and his wife were travelling in a train which met with a serious accident. Many passengers were injured and some killed. Presently the survivors were sent to a hotel, and Mr. and Mrs. B. were assigned a room. The good couple knelt down and thanked God for coming uninjured out of such a terrible experience. Then they went to bed and slept fairly well. Next morning Mr. B. being ready first, said he would go down and order breakfast. A few minutes later his wife found him sitting at the top of the stairs, weeping because he had not courage to go down them. The dread of open spaces, or "agoraphobia," of which he had almost certainly never heard, had been suddenly developed by the accident. Can we arrive at any explanation of a marked condition of nervous weakness starting in this way, and can we by studying traumatic neurasthenia get any insight into the nature of the same condition when it is inherited or the result of non-traumatic influences? Accepting the view that neurasthenia is a prolonged condition of over-fatigue, can it be explained?

It is admitted that every action is performed by an expenditure of nerve force, that not only intellectual and volitional actions are impossible apart from the nervous system, but that even those actions which are concerned with "the brooding and silent life" of the organs of secretion, excretion, of circulation, and of nutrition, all come under the same category; they depend upon their nerve-supply for the power to play their part in the drama of life. They live only by virtue of their nervous activity. In health the nervous force is sufficient for all the ordinary demands made upon it. We work and get tired; we sleep and eat, and are again as new beings ready for another day's work. After some months of continuous work we are tired in a different way; the night's rest and the weekly day of rest do not suffice; we want change of scene and a sustained rest. With these we renew our force and are presently again ready to enjoy work. Even when we are consciously "tired" it is, as a rule, the fatigue of intellectual and volitional nerves, not that of the nerves governing our nutritive and eliminative functions. When these are "tired" and inclined to strike work we recognise that matters are serious, and we know that we are ill. What is it then precisely that happens when nerves, and especially the nerves of vegetative life, are "tired" and do not work? What precisely is wrong when nerve force is exhausted, or even partially exhausted? When not only is intellectual work impossible to us, but when we cannot even digest because our nerves refuse their task? To answer these questions we have to know how the nerves work and how they are nourished. The modern conception of the nervous system has completely altered our views of its physiology, and to a large extent of its pathology. The primary conception to-day is of an essential unit, the nerve cell and its processes. The unit is known as the "neurone"; the nerve cell is believed to be directly and solely concerned with the nutrition of the whole unit or neurone, while the development of nervous energy takes place at the terminal network or arborisation at the end of the nerve fibre, which network is in physiological but not anatomical continuity with the termination of other neurones. Every nerve fibre, with the exception of those in the sympathetic nervous system, is enveloped in a myelin sheath, and the development of this sheath corresponds with the function of the fibre, and its degeneration precedes that of any other part of the fibre. Dr. Waller has apparently shown that the myelin sheath replenishes the energy or power of the fibre, and that it is this sheath which is the source of the inexhaustibility of the nerve. Every neurone is a living unit, and as such it has an endowment of a specific measure of vitality. It can be poisoned by certain toxines having special affinities for it, and certain neurones are much more easily affected by some poisons than by others, as is shown by the influence of syphilis, of alcohol, lead, arsenic, and strychnia on various parts of the nervous system. The paralyses which follow diphtheria, and the action of the poison developed by the tetanus bacillus, are also familiar examples of the selective power of toxines over certain neurones. In each of these cases the poison seizes upon certain neurones almost to the exclusion of the rest. The selective power depends probably on some slight chemical difference in the composition of the cells of the various neurones. The poisons also differ much in the influence they exert on the germinal plasma, and through it on the next generation. Dr. Mott says: "Certain acquired conditions in the parents, affecting them especially at the time of conception, are liable to produce an inherent defect in the germinal plasma. They are acute and chronic alcoholism, syphilis, and tuberculosis." His researches go to show that a very large part of inherited imperfections or weakness of the nervous system results from these acquired conditions in the parents, and especially from the remote influence of syphilis and alcohol on the vitality of the neurones in the offspring.[1] Of the two broad causes of neurasthenia, heredity and stress, heredity stands first, and, except in cases with a pronounced traumatic factor, all well-marked cases of acquired neurasthenia probably have in them an element of hereditary weakness. Again, the analogy with insanity is close.

Hereditary neurasthenia then results from the inheritance of nerve cells of inferior type with a poor endowment of vitality and of nutritional force. It is not necessary to suppose that the vitality or power of repair in the various neurones is never equally distributed. Some may be much better endowed than others, just as we know that the neurones that serve the organs of the special senses and the intellectual processes vary indefinitely in individuals, and in the varying states of health in the same individual. Those neurones in which the inherited power of repair is small naturally break down in function more readily than do those which possess a better endowment of vitality. The symptoms of neurasthenia vary with the functions of the neurones affected, with the proportion of the well-nourished to the ill-nourished, and possibly with the measure of repair, imperfect as it may be, still possible to the least well-endowed neurones. For it does not appear to be common, looking at neurasthenia from a clinical point of view, for inherited or congenital neurasthenia to lead to the absolute loss of vitality of any of the neurones. They repair themselves badly, and function with difficulty and imperfectly, but they do not die. If they died there would not be weakness, but a slowly increasing paralysis. Thinking diagrammatically, we may picture to ourselves ten neurones assigned to one function. If five of the ten are nourished poorly the function will be less perfectly performed than it would be if all the ten were capable of doing their full share of work. The work of any organ would certainly cause the sensation of fatigue more rapidly if half the neurones engaged in that work repaired themselves with difficulty than would be the case if repair in all the neurones went on at a normal rate. Congenital neurasthenics of a high grade are people who may truly say of themselves that they were "born tired, and have been tired ever since."

Acquired neurasthenia, whether traumatic or non-traumatic, is the result of strain, or of some considerable interference with the normal rate of nutrition. In traumatic cases the strain has been more acute and direct than in the non-traumatic cases. But "undue strain" is itself a complex phrase. It implies that the strain is considerable, and that it is more than the individual is fit to meet. A task that would strain a pony is nothing to a cart-horse. To preclude strain the back must be fitted to the burden, and if it is not so fitted there is disturbance of due balance between waste on the one side and repair on the other, between the dissipation of nervous force and its recuperation, and a complex train of nervous symptoms arises which we ascribe to "strain." But in trying to define "strain" it is of prime importance to remember that the whole thing is relative. Most of us have known people who can carry on work at high pressure under conditions that would be impossible to the general run of human beings, and for a very much longer time. For instance, Balzac is said to have written more than one of his novels at a sitting, keeping himself going for an almost incredible number of hours upon coffee, and taking no sleep till the entire volume was finished. It seems even to have been his rule for several years to rise at midnight, after six hours' sleep, and to work at his desk without intermission, but for a little food and much coffee, for fourteen or fifteen hours. The writer knows a contractor who makes the most abstruse calculations, involving immense sums of money, with his children romping round him while at work. He dictates to two or three secretaries in succession, going from one to another, and wearing out relays of them, sometimes for forty or fifty hours at a stretch, without sleep and with only snatches of food. Then he will say, "Excuse me, gentlemen, I am a little tired," and he lies down on the sofa, sleeps for twenty minutes, awakes quite fresh, and is ready to begin again. A man of this type must have powers of repair very superior to the average, and to such a one indirect strain from prolonged brain work would be almost impossible as long as his amazing and unusual powers of recuperation last. Directly he becomes unable to sleep between his bouts of work, from anxiety or any other cause, symptoms of strain will appear. While his health lasts, and things go well with him, more work will not easily strain him. No doubt also, though he can to a great extent postpone food and sleep when necessary, he does in the end take plenty of both. He works longer and harder than ordinary people can, but he can sleep and eat to match when the work is done. Where there is undue strain the individual is often not merely working as hard as he can, but he is trying to do work for which he is not fitted, or he is doing it under distracting conditions. Very often ambition has outrun power. A large number of cases of non-traumatic neurasthenia begin in early adult life or in adolescence. It takes several years for people even of good stock to recover from the strain put upon them by rapid growth and by development. Young adults, and especially young women, are far less fit to stand hard work at nineteen or twenty years of age than they would be, if all goes well with them, at thirty. If they overtax their powers, and if their nerves of digestion break down, sleep presently goes too, and the vicious circle which we call neurasthenia is round them. Still more likely is this to happen if there is an inherited tendency to poor nervous vitality, though the individual himself has not hitherto been conscious of nerve weakness.

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[1] Dr. Mott's *Croonian Lectures on the Degeneration of the Neurone*, 1900.

Deficient or imperfect metabolism is also probably an important etiological factor in many cases of functional nervous disturbance or failure. When metabolism is imperfect not only is nutrition checked, but there is a resulting auto-intoxication which must itself directly interfere with normal nerve functions. A large part of what can be done to improve the nutrition of nerves has to do with quickening metabolism, getting rid of waste material, and bringing the leucocytes everywhere into a higher degree of resisting power as against noxious influences (*vide* "Immunity," vol. v. p. 166). The effect of a general increase of the natural powers of resistance to bacteria which leucocytes possess is well shown in the results gained by the open air and high feeding method of treating tuberculosis. In functional nervous disease we know of no bacterium which has to be resisted and checked in its development, but the success of the Weir Mitchell method, which in many important points resembles the new treatment for tuberculosis, shows how much benefit the nervous system can obtain from promoting the general metabolism of the whole organism. The presence in the blood plasma and lymph of the chemical products resulting from imperfect metabolism must also seriously interfere with the nutrition of the nervous and other tissues.

Symptomology.—The symptoms of neurasthenia vary almost indefinitely with the part of the nervous system at fault. Sometimes the failure seems to be limited to the cells of the brain itself, in other cases it is the spinal nerves that fail prominently; in a third and large group both cerebral and spinal sub-systems are at fault. The individual is either incapable of ordinary exertion of mind and muscle, or he has broken down in both directions under unusual stress. Therefore we have the cerebral, the spinal, and the cerebro-spinal subdivisions of neurasthenia. In not a few cases the failure is most marked in the nerves of organic life, and finally, there is the group in which it is chiefly seen in the nerves of the sexual organs. But after indicating these varieties, it remains true that there is in most cases a certain profound unity which links all the cases of nerve weakness more or less together. No one important set of nerves can fail in its power of repair and in its consequent power of work without its failure being, as a rule, and in a measure, felt or reflected by every part of the nervous system. All the better behaved and more normally acting neurones hold their propriety of conduct, *i.e.* their power of repair, on a more insecure tenure when neighbouring and related groups of neurones are gravely out of order. "If one member suffers, all the members suffer with it," is true, broadly but not absolutely, of the nervous system. The cerebral type, however, is not rarely seen in men and women who show no trace of muscular weakness. They can walk, climb mountains, cycle long distances day by day, with no more fatigue than other people, but they cannot accept responsibility, and they cannot even apply their minds continuously to any one subject, active attention being one of the latest acquired mental powers, and one of the first to be lost. If these people attempt to take responsible work they cannot sleep, and with loss of sleep, temper and self-control quickly suffer. Very often such a man cannot endure anything like a crowd, especially an enclosed crowd. He dare not go to church, or to a theatre or concert, or to an evening party. He suffers from "claustrophobia." Another patient of the same type has a horror of open places, he will do anything to avoid having to walk across a market-place or even down a wide staircase. He has "agoraphobia." Morbid fears of many other kinds are often present. "Anthropophobia," fear of society, of meeting anyone out of the most intimate family circle; "monophobia," the fear of solitude; "pathophobia," the fear of diseases; "pantaphobia," the fear of everything; "mysophobia," the fear of contamination, are among the best known of these morbid fears, but they by no means exhaust the list of the things that neurasthenics dread. A lady known to the writer dared not see the reflection of her own face. The greater part of her life for years was spent in trying to avoid the risk of meeting by accident a looking-glass, or of turning inadvertently towards the plate glass windows of shops. She was not insane, and she recognised clearly that the horror was an absurd one, but all the same it held her for long in bondage. It is usually said that neurasthenia does not lead to insanity, and in general terms this is true. It is, however, impossible to doubt that the dividing line between chronic delusional insanity or insane obsession combined with impulse and the conditions described above is not a broad one. Further evidence in this direction is the fact that a good many neurasthenics talk of suicide as a possible thing, though few of them do more than talk of it. Insomnia with them is a continually returning evil, and vertigo is common. There is also frequently preternaturally acute hearing or even aural obsessions. A lady who has been neurasthenic for the greater part of a long lifetime has both aural and visual hallucinations when she gets in the least below her ordinary poor level of strength. In a recent letter to the writer she says:—"One of my old conditions has at this moment again taken hold of me. A short tune of four bars of poor music is being played by a poor little instrument in the air; if the windows were open it would be in the trees in the garden, and it goes on many times in a minute, quite incessantly, till another such little tune takes its place. When I wake in the morning it will wake with me, a wretched little ghost of a tune I have never heard before. This has gone on ever since my last illness, robbing me of the pleasure I used to have in going through in my mind real fine music I had heard from the best artists. Once when ill I heard a fine band playing in a field near, but after a few weeks when the illness ended the band ended too. I see some odd things still, but I am glad to say I no longer see decapitated heads of hideous men floating in the air." This lady is perfectly conscious that the things she hears and sees are illusions, she is a woman of great intelligence, of many gifts and mental activities, and she is not self-absorbed. The main type of her neurasthenia is spinal, she can take no exercise at all without being conspicuously the worse for it, but when she is ill she gets indications of the failure of the cells of the special senses to function in an orderly way. Her case is specially instructive, as four of her five children are, like their mother, spinal neurasthenics in spite of possessing unusual mental powers. Two of the three sons have been obliged all through life to limit most strictly their amount of exercise. They were each in succession taken away from public schools by the advice of the school doctor because "the games were killing them." By dint of great care in the avoidance of muscular fatigue they have done well in their respective callings, but if they try to live like other people they lose their sleep and cease to be able to digest. One is now in the Royal Engineers, one an author of some distinction, and the third a brilliant professional musician. The daughters are of the same type, very able mentally, and yet quite unable to bear muscular exercise. An amount of exercise that would be absolutely nothing to ordinary people would in both of them arrest digestion and the power of sleeping for several days. The history of this family is a good illustration of what has already been said of the interdependence of the various types of neurasthenia. In the mother it is mainly spinal with cerebral symptoms occasionally superadded. In the sons and daughters it is again mainly spinal, but with the nerves of organic life failing in their work when muscular fatigue is induced. To the inexperienced young practitioner, who combines a firm and wholesome belief in the laws of health with a tacit disbelief in "freaks" who cannot obey these laws, such cases are at first a puzzle. He has been used to young women who can play hockey and cricket, who can hunt and cycle, dance and climb mountains, and he begins by doubting the very existence of genuine nerve weakness apparently without cause and without structural disease. But after a time he has to admit that "freaks" do exist, to whom physical exercise is so far from beneficial that the limited degree of health to which they can ever attain is only to be reached by the careful avoidance of every form of exercise. Normal such lives are not, but in abnormal conditions all we can do is to make the best of what has to be endured, and not to err by dogmatically insisting on one programme for everyone, be he sound or unsound.

Among the leading symptoms of cerebral neurasthenia is tenderness of the scalp, sometimes diffused, oftener located in certain areas, especially over the vertex, or the eyebrow, or nape of neck. The pupils are very usually dilated, and they are often temporarily unequal in size. There is a form of asthenopia which depends not upon faults of accommodation, but purely upon the nerves. This form cannot be cured by glasses. Reading, writing, and sewing are often accomplished only with great pain, and the conjunctivæ get congested in the attacks. The teeth decay early and rapidly in neurasthenics. They feel extremes and changes of weather more than healthy people. Great heat tries them even more than cold. Sunstroke in its minor forms often brings on many symptoms of neurasthenia in a person previously well. Sunstroke that kills does its deadly work by the destructive action of heat on the neurones governing the actions of the heart and lungs.

Beard thinks that unusual size, especially in men, often goes with great nervous debility. He says that many of his patients were "giants," and that "it cannot be too often repeated that a patient may be of great size and weight, and have a muscular development both large and hard, capable of great physical endurance, and at the same time be in his nervous system as weak as a bedridden hysterical girl."[1] Very unusual size certainly tells against constitutional vigour, especially against the power of the heart to maintain itself in serious illness. It is generally noticed, too, that exceptionally big people are less well endowed mentally than small or medium-sized individuals. Both these observations go to support Beard's statement as to the proclivity of people of very large frames to nerve weakness. The symptoms in many spinal cases are often, more or less, localised in the spine, and do not necessarily involve the visceral nerves. Many of the aching backs that delicate women complain of are neurasthenic in origin, and can be cured far more quickly by massage, feeding, and rest, than by gynæcologists. These are the cases that a while ago were labelled "spinal irritation," or "irritable spine," and about which the brothers Griffen wrote much that was practically wise if pathologically crude. Sometimes the spinal weakness advances to a kind of imperfect or spurious hemiplegia in which there is decided weakness on one side without loss, but often with many disturbances, of sensation. Anæsthesia is far less common in neurasthenia than in hysteria. Patients often complain much of the extreme coldness of their legs, feet, and hands. This is probably due to vasomotor disturbance leading to undue constriction of the arterioles. It is usually connected with imperfect metabolism, and it is often best treated by medicines which promote elimination and diminish arterial tension.

Visceral Neurasthenia.—Over-fatigue of mind and body not unfrequently expresses itself almost solely by partial failure in the functional activity of the nerves of organic life. In many of these cases there is no backache and no special symptoms of spinal disturbance, but all the abdominal organs seem to be conspiring together to do their work in a grudging spirit. Two instances of this may be given as illustrations. A lady of 43 years of age, who had never had much exercise, took to cycling. She enjoyed it greatly, and frequently rode for long distances. She was a tall, big woman weighing about twelve stone, and in addition to the fatigue anyone of this weight would feel, it was not easy to get a perfectly comfortable saddle. After some months she began to have great difficulty in digesting any ordinary food, the bowels were much confined, the evacuations abnormal, and sleep imperfect. The constipation and flatulence were so distressing that the possibility of malignant stricture of the bowel was considered with some anxiety. After many months of ill-health a change to the Riviera gave her nerves a fillip, and in course of time she recovered the power of digestion and is now quite well. In the next case there is a very neurotic history. The patient, a young woman of about 30, was supporting herself by teaching, and at the same time working for the London M.A. degree. She came of a nervous stock, one sister being in an asylum and both parents highly nervous. She worked hard, fed poorly, and came out in honours. Then she collapsed, complaining of many digestive troubles and of constant pain in the region of the pylorus. She was ill for many months, but gradually recovered with rest and tonic treatment. In both these cases the nervous fatigue had apparently manifested itself only in the nerves of the abdominal viscera.

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[1] Beard on *Nervous Exhaustion*, 1890, p. 117. Lewis.

The writer saw once in consultation some years ago a patient in whom the functions of defæcation and urination were almost completely arrested without any real paralysis. She was a single woman, 33 years old. Her trouble began suddenly ten years earlier, when her father, an old man of 75, had had a sudden attack of retention of urine, which necessitated afterwards the habitual use of the catheter. The daughter's story was that from that day she had never been able to micturate naturally—"it took hours at her worst and minutes at her best" to pass water. The bowels were in much the same condition of suspended power. Her "whole life was occupied with the labour of getting relief of the bladder and bowels. She was anæmic and thin, and she slept and ate very badly. There was no evidence of anything wrong outside of the nervous system." Still more remarkable are the cases in which the secretion of urine is for a time almost completely suppressed. The writer was for some years familiar with a patient in whom any undue fatigue or nerve worry or loss of sleep was followed at once by almost complete absence of urine. The total daily amount passed would be 4 or 5 oz. in the twenty-four hours, sometimes, according to the patient's own story, even less. So far as could be estimated, the amount of urea was often less, for several days in succession, than one-quarter of the normal amount. These statements could not be actually verified, as the patient lived at a distance, but it is certain that the amount of urine was very much reduced, and that the urea it contained was not proportionately or even actually increased. By sending the patient to bed, purging her gently, and following it with iron and liquor ammon-acetatis in moderately large and repeated doses the secretion was usually soon restored. The condition here seen is commonly called "hysterical," and it may be that it is correct to so describe it. The patient in question, however, was not "hysterical" in any other way. All that one could be sure about was that her renal nerves were prone, upon fatigue of mind or body, to strike work.

Charcot believed that in these cases of nervous ischuria the explanation of the absence of grave symptoms must lie in a remarkable arrest in the formation of excrementitious material. But even if we accept this view it is surprising that catalytic activity can be so considerably checked, unless next to no food or exercise is taken, without serious results. In the patient seen by the writer there was discomfort of a marked kind, but no symptom of grave import, in spite of most marked diminution in the daily excretion of urea. Both the cases narrated were extreme instances of visceral neurasthenia.

The sexual form of neurasthenia is probably much more common in men than women. Some cases of ovarian pain are no doubt due to neurasthenia, but they are rare as contrasted with the cases in which pain is due to imperfect development or to atrophy of the ovaries, to anæmia or to tubercular or inflammatory mischief of the ovaries or Fallopian tubes. In support of this view it may be remembered how many cases of ovarian pain are now cured by surgery. Thirty or forty years ago many of them would have been confidently labelled "ovarian neuralgia."

The relation of neurasthenia to diseases of the female reproductive organs has been a battlefield for rival schools of thought for many centuries. No doubt the reflex nervous relations between the reproductive and other organs are always numerous and important. Nevertheless it is possible to exaggerate their importance, and to attribute to the influence of this part of the organism far more than properly belongs to it. Probably the truth is, that in conditions of nervous instability and malnutrition all reflexes are increased, and that a trifling abrasion of the cervix may under such circumstances be the cause of reflex disturbances that would never be seen in a person of good nervous health. For it is certain that in a large number of women reflex disturbance is not seen in the presence of pelvic ailments, either grave or trifling, and also that where such disturbances are present they can often be cured by treatment addressed mainly to the general health, and to the nutrition and maintenance of balance in the nervous centres.

Sexual excesses are much more frequently the immediate cause of neurasthenia in men than in women. Excess in this as in other things is a relative term. A very moderate amount of sexual indulgence is enough to produce in some men a condition of neurasthenia which may be most marked, and may remain permanently. It is not very uncommon to hear of cases that began immediately after marriage. The writer is acquainted with a case in which the patient had worked very hard and successfully in establishing a large business, often going for many weeks at a time with very little sleep and irregular meals. When about 35 he married, and before the honeymoon was over he developed serious symptoms of cerebral neurasthenia. He was never again able to take any responsible work; he had a horror of closed places, could not go to a theatre, concert-room, church, or crowded drawing-room. He lived for more than twenty-five years after marriage, never sleeping well, and frequently being unfit for even a life of trifling occupations. Of his six children the eldest son alone has inherited the father's neurasthenia. He has trained himself for two professions with, as a student, a considerable amount of distinction, but he can practise neither. The least bit of responsibility is more than he can bear; he loses his sleep at once, and is immediately a nervous wreck. The son, unlike the father, is able to take a great deal of muscular exertion without apparently being the worse for it. He can read and study to good purpose so long as he has absolutely no responsibility. In both these cases the general sense of illness was often very great and the nutrition poor. The son has wisely remained celibate. In the case of the father there was probably no actual excess in the amount of sexual activity, but what there was destroyed the unstable equilibrium between the expenditure and repair of nerve force.

The influence of unnatural stimulation of the sexual organs on the nervous and general health of the individual is not easily determined.

Probably the physical evil of such unnatural stimulation depends much more upon the extent to which it is practised, if it is allowed to become a habit, than upon the nature of the stimulation itself. There can be no question as to the evil physical effects of the habit, when it exists, when the mind is constantly turned towards the gratification of the sexual instincts, and when by auto-suggestion the sexual nerves are more or less constantly being excited. But this is rarely seen in perfectly sane people. Masturbation is extremely common in imbeciles and in persons of imperfect or very poor mental development, but in them it is the result and not the cause of their imperfection. The sense of moral degradation and the loss of self-respect and of self-control which result in sane people from self-abuse are its real and gravest penalties, and it may be doubted if there is any physical result, especially in the case of women, in the absence of a dominant habit. Practically it is not usually wise to treat confessions on this score from apparently healthy people in too serious a manner. They have gratified an animal instinct in an irregular way, and it is undesirable. Let them turn their thoughts resolutely into other and wholesomer channels, let them fill their minds and tire their muscles, and the temptation will depart. Advice of this kind helps their self-respect and self-control much more than it would do to treat their confession as if it were of a heinous sin, for which they must be full of remorse, and which they might never forget. What they want to escape is being enthralled by a bad habit, and with this in view they must get their minds thoroughly occupied with other subjects.

Diagnosis.—The diagnosis of neurasthenia is often extremely difficult. The observer should never decide hastily as between organic and functional nervous disease. The golden rule is to look for organic and to expect to find functional disease. Sir William Gull's aphorism, that "we make many more mistakes by not looking than by not knowing," is specially true when applied to the diagnosis of nervous disease. Look carefully for evidence of organic disease. But to do this to good purpose implies that we know what to look for. "The eye sees only what it brings with it the power of seeing." Having found no objective evidence of organic disease, listen to the patient's story, asking no suggestive questions. If a neurasthenic patient is encouraged to narrate his experiences and symptoms, there will, as a rule, be ample evidence against organic disease. No system disease one knows of ever had half the variety of symptoms and the variation of conditions described by the neurasthenic. The symptoms of organic disease vary very little from day to day, while those of neurasthenia are constantly changing, fleeting, metastatic, and recurrent. In organic diseases the reflex activity is often diminished; in functional it is usually increased. Still in many cases the diagnosis cannot be made at once. It is better to wait and watch even for weeks than to overlook organic disease. The diagnosis of neurasthenia from other functional disease is both less difficult and less important. We have to think of hysteria, insanity, perversions of temper, and such moral defects as indolence, selfishness, and malingering, neuralgia, and the larval forms of Graves' disease. With a clear picture of neurasthenia in our minds, it is not usually difficult to distinguish it from any of these, though, as Dr. Clifford Allbutt well says, "water-tight compartments" must not be expected in functional nervous disorders. Happily the name we give to an ailment often matters much less than how we treat it.

Prognosis.—To form anything like a correct forecast as to the prospect of real recovery in any case of neurasthenia, we require to know much more about the conditions of the patient's life, his nervous inheritance, and his power of exercising self-control and discretion than it is ordinarily possible to know or to find out. Individual prognosis should, therefore, always be given guardedly even in cases of a hopeful class. Still it is possible to say that a large proportion of the minor forms of acquired neurasthenia recover in great measure under proper treatment. Severe cases of inherited neurasthenia do not recover under any treatment, if we take recovery to imply being able to enjoy life and hard work like healthy persons. No one can be sure that a severe case of neurasthenia in a person of bad nervous inheritance can by any method be permanently lifted out of the neurasthenic plane. The neurasthenia which results from sunstroke generally lasts a long time, but under good conditions and good treatment it tends in the end to disappear. Traumatic neurasthenia shows many grades of severity, these grades being probably the resultant in each case of the immediate effect of the injury to the nerve cells and the inherited power of repair in the individual. It is worth noticing, with regard to traumatic neurasthenia from railway accidents, that numerous as are the cases due to this cause, they are still probably only a small minority compared with the very large number of persons who go through similar accidents without any serious nervous injury. This would suggest that most of those who suffer much from the effect of fright or severe jar, apart from actual injury, are not people of good nervous inheritance. It may be that they are more readily injured than their companions, because they are of less stable organisation. In traumatic neurasthenia the prognosis is greatly influenced by the age of the patient, the young recovering much more quickly than the old. In non-traumatic neurasthenia, on the other hand, the prognosis is not specially good in the young, as it almost always implies a bad nervous inheritance.

The prognosis of each case is also much influenced by the power of the patient to command the best methods of care. A great many people are practically too poor to be cured, or even to be materially helped by treatment, because the only treatment that will do them good is costly and extends over a long time. A sanatorium, where the Weir-Mitchell method, with all its expensive adjuncts, could be applied for three guineas a week would not be remunerative to its proprietor, and even such a one would be too dear for a large number of the persons who would be the better for the treatment. Even prolonged rest and extra feeding at home are impossible to most people who work for their living.

PATHOLOGY AND MORBID ANATOMY.—Very little is known or likely to be known as to the changes or processes that underlie imperfect nutrition or repair in the ultimate units of the nervous system. Dr. Clifford Allbutt, who has written much that is wise and suggestive about neurasthenia, says on this point:—

> If it be true that in many such persons the nervous organs seem to have fallen short in capacity, it is no less true that a mechanical cause can induce the same phenomena in persons originally of full nervous capacity. Perhaps in persons originally endowed with ample nervous volume a dislocation of neurons, a sluggishness of the ancillary processes of these systems, or some such retrogressive state of nutrition, as Hodge and others have demonstrated in the nerve cells of over-worked wasps, may be equivalent to an original defect of capacity. On the other hand, as rest, massage, and high feeding cure a large number of patients, even in cases of traumatic origin, it would seem as if the pathological condition were not a mere solution of continuity, or if so, that the feeding and the other means promote a growing up of the gaps. The apathy induced by the Weir-Mitchell method may give the parts the quiescence they require for assimilation and readaptation. But this is mere speculation. The attribution of abnormal irritability or "over-excitability" to nervous structure in disease is absurd. No nervous matter was ever too excitable; to be excitable is its business; in "over-irritability" a race-horse differs from a jackass. The more excitable our nerves the quicker and

> higher our life. Of nervous matter instability is the peculiar virtue; the fault in neurasthenia is that the vibrations of the sense organs, instead of being absorbed into the larger harmonies of the nervous system, take to "short circuiting," whereby their energy is wastefully dissipated. In many of the inherited cases I suspect that the nervous centres, however high and various in quality and complexity, are deficient in volume or in blood-supply. Bodily, mental, or emotional strain may produce neurasthenia with the suddenness of a traumatic cause; young persons fagged by long mental application, by prolonged muscular exertion, performed for a time perhaps without a sense of undue fatigue, or again by the continual harass of ill-fortune, may show no patent effect till the condition reveals itself all at once. . . . Young women are much more prone than young men to break down in this way, and almost without warning; many women never get over a long and ambitious course of study, or a long course of athletic exercises. After some considerable duration of stress, borne for a time with apparent ease, the breakdown may occur very suddenly, and resist the remedial power of Nature or of the physician. . . . An intimate friend of my own tells me that some twelve years ago he was persuaded when he had gone out of training to take a vacant place in his college boat in the May races. Each day's race was a hard one, and the stress so told on him that he has never been able to withstand any hard mental or bodily work since that time, though his general health is excellent. Sometimes I am tempted to exaggerate this peril when I remember the many women, and not a few men, who, having taken high honours at the universities or elsewhere, out of their own circle are never heard of again. . . . Happily it is true, on the whole, that to cultivate the highest powers of the body and mind is to strengthen self-control and that self-conscious inhibition which govern us in our habits of life, but if we overdo the highest nervous centres, and empty their reservoirs—*quis custodiet?*[1]

Without depreciating Dr. Clifford Allbutt's warning, it is well to remember that a very large proportion of the women who distinguish themselves in examinations speedily marry, and are absorbed from that time in the family life. They do not look to be heard of beyond their own circle. A large number also go into the profession of teaching, which is for the most part in its relation to the outside world a silent one. The two "eloquent" professions, the Church and the Bar, are not open to women. Moreover, in the case of both men and women, many qualities other than ability and brain capacity are required to make success in life certain. Many of the people who do best in examinations are lacking in the common sense and tact so much wanted in ordinary life. It is by no means certain that all whom Dr. Allbutt has noticed as "dropping out" of the race after university life have suffered from their hard work. Moreover, to speak of "emptying the reservoirs" of the highest nervous centres is surely to use words which obscure thought rather than illumine it. Is there any ground for supposing that we have that which even by a metaphorical stretch of language can be called "a reserve of nerve force"? Surely all we can suppose is that the force of the higher nerve centres and of all other centres is meant to be used, and should be used, but that it is also meant to be constantly renewed by the daily and hourly processes of repair, which processes depend upon sleep, relaxation, and nutrition. We are all neurasthenic when we are dead tired from want of sleep, undue exertion, and the absence of food. Is any ordinarily endowed person good for anything if he misses two or three consecutive nights of rest, if he not merely does not sleep, but cannot even go to bed and rest his muscles, if he is obliged to go on exerting himself long after he is tired, and if he has had during the same time very little food? There is no question here of "emptying a reservoir." The process of repair has been arrested, and profound exhaustion is the inevitable result. The momentous question in such a case is, Will the repairing functions start work again when permitted by circumstances to do so? or are the nerves by which the repairing functions themselves are controlled and vitalised so broken down and disorganised that rapid repair is impossible? A wise man who is much over-tired knows by experience that till he has had a long rest he must ask very little from the nerves of his stomach. Repair by way of food is not at once possible. He will take the lightest and simplest liquid food, and not much of it. He will have a quick sponge-bath with hot water, and will go to bed and stay there if possible till he has next morning digested another very small and light meal. Whether he will suffer for a long time from the exhaustion due to undue expenditure of nerve force depends upon two questions. Will sleep be at once or quickly possible to him? and will the nerves of nutrition quickly recover sufficiently to supply the cells of the brain and spinal cord with the pabulum they need for their restoration to activity? If the nutrition of the higher centres is so far enfeebled that sleep from the first is difficult, imperfect, and scanty, the vicious circle is begun. The nutritional nerves are day by day still further depressed, in the absence of natural and restful sleep, and they presently give out, and cannot work at anything like the normal rate. Then the circle is complete. Tired nerve cells of brain and cord, irritated by imperfect blood-supply, no sleep possible, nutritional activity very low, repair therefore almost nil, neurasthenia the result. The circle once forged is terribly hard to break. It can only be broken by gradually restoring the processes which make for repair, *i.e.* the power of sleeping and the power of digesting, and by checking in the meantime everything which increases the expenditure of nervous energy. An over-driven horse, dropping down under the burden of dragging a too heavy load uphill, does not want the whip, but that his load should be lightened. A student who tries to live upon coffee because it puts off sleep and diminishes the sense of hunger, and enables him for a time to do with very little of both sleep and food, is recklessly trifling with his powers of repair. He is with ignorant rashness putting his name to a physiological "bill" which he will, in too many cases, find it hard to meet even at the end of years of damaged nerve force. Nor is it only in nervous failure that overstrain makes itself felt. Long-sustained high tension tells directly upon the heart, and in many cases also on the nutrition of the arteries. In Balzac's case, a man of naturally great constitutional vigour died at the age of 50 of dilatation of the heart and its consequences. As one of his biographers writes, "His excess of labour, his sleepless nights, his abuse of coffee, had undermined his seemingly indestructible health.[1]

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[1] Allbutt's *System of Medicine*, vol. viii. pp. 150, 151.

TREATMENT.—(*a*) *Preventive.*—Acquired neurasthenia is one of the many things which it is easier to prevent than to cure. Parents and schoolmasters and mistresses might with advantage know more than they do about the risks of overstrain, both as to mental work and exercise, and about the difference in nervous strength between some children and others. Even in the best public schools for boys the food is too often not as good as it should be, bearing in mind how rapidly boys grow and the amount of exercise they constantly take. It is almost impossible to give growing boys and girls too much food, provided it is simple and sufficiently varied; they ought not to be obliged to get food for breakfast, etc., from cook shops because the food provided at school is unattractive or badly cooked and served. With girls it is almost always difficult to get them to eat enough between the ages of 14 and 18; if they are at all anæmic they are dainty and fastidious; by eating little the anæmia is increased and the nutrition of the nervous system suffers with that of all their other tissues. Overstrain of mind or body in the young should be at least recognised as possible, and as far as may be it should be prevented. It is one of the advantages of resident schools over day schools that girls and boys living at school cannot work unreasonably much or late without the head of the house knowing it. When they live at home they fall between the authority of the school-master or mistress and that of the mother, and practically they do pretty much what they like. At school there is much more play, more supervision, and more discipline than at home. Young women at college not very rarely produce varying degrees of neurasthenia by the combination of long hours of work, eating too little, and drinking tea and coffee to excess. Some of them think to take care of their health by being at the same time active members of several game clubs, hockey, tennis, etc. When the excitement ends and their place in the list is determined, not a few are good for nothing for several years to come. It would have been infinitely wiser if they had eaten twice as much of plain food, taken less exercise, coffee only as a rare luxury, and tea not more than once or twice a day. They might possibly have had a less good place in the lists, but in its stead they would have had health and vigour, instead of exhaustion, on entering upon the work of their lives. The influence of coffee in inducing neurasthenia is a point well worthy the attention of total abstainers. It works in two ways, by checking appetite and by preventing sleep. The neurasthenic by inheritance wants to be well nourished, and he needs much sleep. He should shun coffee as he would poison. Dr. Beard points out that coffee does much less harm in very cold and in very hot climates than it does in England and in the temperate parts of America. Possibly the explanation of this, if it be true, is that neither in extreme cold nor in tropical heat is hard work of mind or body possible to the extent it is in temperate climates. Both heat and cold induce lethargy, that is, diminished activity of nerves, and the effect of coffee in conditions of lethargy, as for example in opium poisoning, is to bring up the activity of the nerves to the normal. They are not then over-stimulated by it, because they started from a lower plane of sensibility or of activity. They are roused up to the normal level instead of to a level beyond the normal. People exposed to severe cold even in England are in the same way better for taking coffee in moderation, and it does not then over-stimulate them. The varying influence of coffee in different climates fits in with the fact pointed out by Beard that neurasthenia is greatly more common in countries which enjoy a temperate climate. Continuous work here being possible many more people suffer from nerve-exhaustion than in places where indolence is much more common.

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[1] *Encycl. Brit.* 9th edition.

(*b*) *Curative.*—The treatment of neurasthenia is much the same whether the condition is due to an accident, to over-strain, or to a faulty inheritance. The limitation of the patient's powers must be recognised, and all excessive calls upon them avoided. He wants a great deal of sleep and much food. When he sleeps soundly and eats liberally he is on the road to recovery. The difficulty of treatment lies mainly in the inability to sleep or eat naturally, and in adequate amount. Practically the important question with all severe cases of neurasthenia is whether the Weir-Mitchell method is necessary, or whether they can be cured by simpler means. No absolute indication can be given on this point. All severe and chronic cases should try the Weir-Mitchell plan fairly and fully if they can afford it. It costs upwards of £200 if the after-cure holiday with a trained companion be included in the reckoning. An important point in the success of the Weir-Mitchell treatment is that the patient should wish to try it. If he is forced into it against his will it often fails. The essential features of the method are absolute rest for some weeks, seclusion from friends, letters, family, etc.; a very liberal dietary, and massage and electricity to promote digestion and the nutrition of the muscles. Each case needs to be specially watched, and the diet to be suited to the powers of digestion. Very good nurses, too, are essential. They must be bright, kindly, sensible, and agreeable. The main difficulty about applying the method is to find exactly the right kind of attendant. In favourable cases three stone of weight is put on in six weeks, the patient by the end of the course is sleeping naturally, and is presently able to resume ordinary life. Relapses, however, are not very uncommon, and patients are usually very unwilling to go through the treatment a second time. When it is impossible to order a course of this kind in the hands of experienced people something may be done, if the patient is docile and really willing to be cured (which is not invariably the case), by ordering a definite and large amount of rest, preferably with one companion away from home, and a definite and liberal dietary. Many slighter cases have, in the writer's experience, improved immensely by staying in bed till mid-day for a month, with window wide open day and night, in a quiet and sunny room, and with the addition to each meal of a slice of old bread well buttered and a tumbler of milk. Of drugs there are the bromides, laxatives, and special nerve tonics, such as valerian, the salts of zinc, quinine, and iron. It is a mistake to think drugs are useless. Much may be done by their aid if given wisely and courageously. The bromides are invaluable where sleep is very difficult. They should be given in large doses for a short time till a powerful sedative effect is produced. Three or four days of large doses (gr. 30, 40, or 50 at a dose) are usually enough. The effect should be watched. Bromides do not agree with every one. After the bromides, and following them, the salts of zinc, the valerianate, bromide, and oxide should be given, and if possible with them cod-liver oil. After a week or so of the zinc salts, the mineral acids with nux. vom. in full doses, and arsenic in minute and gradually increased doses, should be given for a month. Baths of many kinds are also invaluable in conditions of neurasthenia. The refreshing effects of a large hot bath, and even of sponging the face for a minute or two with quite hot water, are familiarly known. We are not quite sure how the hot water acts upon the central nerves, but there is no doubt that it does affect them for the moment very much as sleep does. It refreshes, and it is refreshment that weak nerve centres crave. The notion that hot water is weakening is an error. If quite hot and applied only for a few moments and as douche, not in the form of a large bath, it is invigorating. Where the Weir-Mitchell method is impossible it is well worth while to prescribe three or four daily short douches of the neck and face with water of 105° F. or more, and to order the feet to be put into still hotter water for two or three minutes twice a day perhaps, in the afternoon and at bedtime. As the case improves the morning douching may be done with moderately cold water, till in the end the patient is taking a sitz bath every morning in water of 60° F., and a quite hot sitz bath every night.

It is well to order definite treatment and only for a limited time, not to let the patient impose his invalidism on the household permanently. Six weeks ought to be long enough to enforce a strict mode of life, and at the end of the time decided upon, the patient should have another set of rules to act upon permanently.

In framing these rules great care should be taken not to impose needless burdens on the patient's family. Neurasthenia is not hysteria, but, like other people, the subjects of neurasthenia can also be hysterics and much too engrossed in themselves and their symptoms. In their own interests they should be encouraged to think of the welfare and comfort of others as much as possible. For instance, a neurasthenic woman who has been helped by a six weeks' course might be told to have every day two hours of complete solitude and quiet, to be in bed by 10 P.M. and not up before 7.30 A.M., and to take certain specified spongings and baths. Inside the given rules she should be encouraged to live a normal and social life, and to think of everyone rather than of herself. It is better that all neurasthenics should know that their special type of constitution cannot be altered or got rid of. It will stay with them, and they must make the best possible of their lives in spite of it. They must not be wasteful of their nervous strength, they must use what they have wisely, and look carefully to its renewal by food and sleep.

We are often asked if neurasthenia is not increasing. Probably it is. As the evolution of society advances the demands made upon the nervous strength of the majority of people are bound to increase. The weak ones feel the added burden, and they will fall out in increasing numbers unless their inherited nervous development keeps pace with the evolution of society. It is useless to wish to go back to a more primitive and simple life. It is better to think of what might be done to raise the general standard of nervous strength by the promotion of temperance and self-control in those from whom the next generation will inherit their nervous organisation. The world has not yet seen, possibly it will never see, how far nervous disease and nervous weakness could be diminished by getting rid of the influences which lead, directly and indirectly, and possibly through several generations, to a low level of vitality and to inherent defects of nutrition in the units of which the nervous system is the aggregate. And though it would be Utopian to hope that at any time in the future the perfect development of all civilised human beings shall cease to be checked by malign influences which need not have existed, it is reasonable to hope that with a gradual advance in knowledge, in ethics, and in moral strength, such influences will in time be much less often responsible for a bad nervous inheritance than they now are.

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Neuritis. *See* Nerves.

Neuroma. *See* Tumours.

Neuroses, Occupation.

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By the term "occupation neuroses," or fatigue spasms, is meant a group of functional disorders, characterised by muscular spasm, pain, tremor, and weakness, which are provoked by prolonged employment of the special movements called for by the occupation or trade concerned, and by no other, the same muscles being capable of being used normally for all other movements. The disease must then be sharply distinguished from many craft palsies which are due to local muscular wasting, such as the wasting of the hand muscles, which may occur in many trades, and from diseases directly due to some toxic element in the particular trade, such as lead neuritis in painters, brassfounder's ague from inhalation of the fumes of deflagrated zinc, mercurial tremor, etc. Even more carefully must fatigue spasm be distinguished from local muscular weakness and pain due to early organic disease as neuritis, syringomyelia, or new growths.

Etiology.—Writer's cramp, or scrivener's palsy, is by far the most common of these distressing affections, but other forms met with are violin and violincello players' cramp, pianoforte player's cramp, sempstress's cramp, telegraphist's, sawyer's, milker's, tailor's, treadler's, ballet-dancer's, compositor's, cigarette-maker's, card-player's, letter-sorter's, knitter's, and hammerman's or smith's cramp, miner's and mountaineer's nystagmus, clarionet and flute players' and glass-blower's spasm of the lips, and indeed many others. Spasm of the hand in barbers, when holding the razor, has been recorded, and I have also met with a case of typical occupation neurosis in a hairdresser æt. 19, numbness and marked weakness in the right hand, with pain in the wrist and forearm after work, followed three weeks later by cramp and spasm of the hand muscles, occurring in the mornings, and lasting for some hours daily. The symptoms did not commence until he had followed his employment for three years, and was therefore perfectly accustomed to haircutting. This point is typical of all the occupation neuroses, that the spasm and pain are not developed during the learning of the art or trade, when the muscular effort and attention involved are the greatest, but in the stage of perfection of manipulation, when the act has become practically automatic.

Writing Neurosis.—Writer's cramp forms the large majority of all cases of occupation neurosis, and occurs especially in those who are accustomed to do their writing in a cramped style, holding the pen low down near the nib, and taking the little finger as the fixed point, in order to produce "copper-plate" writing, by various movements of the thenar and interosseous muscles. It is writing in this cramped style for long periods at a time which especially predisposes to the affection, and lawyers' clerks, and others who gain their livelihood by copying in a clear hand, form a large proportion of the sufferers. Shorthand writers and others who cultivate a free style of writing from the shoulder and elbow scarcely ever suffer from this complaint. Neuropathic heredity plays an important part in the development of these neuroses, and there is often a history of epilepsy or insanity, asthma, torticollis, hysteria, or even writer's cramp itself, occurring in other members of the family; for example, five members of one family I have met with suffered from writer's cramp; or the patient himself may suffer from migraine, convulsive tic, or stuttering. Anxiety, business worry, or other prolonged mental stress may predispose to its development, while a similar result may be precipitated by local injury of the limb, such as a sprain or periostitis, or after recovery from an attack of hemiplegia or any debilitating illness. The excitement produced by attending a spiritualist séance has been known to be followed by the development of writing spasm, and indeed by many other psychoses and neuroses. The large majority of sufferers are of the male sex, and between twenty and fifty years of age. Females only occasionally suffer, probably on account of their daily bread not often depending on writing day by day for hours, and the prognosis when such trouble does occur is consequently better than in most men, who usually find it more difficult to put aside the daily toil and take the rest from the harmful employment that is absolutely essential to a cure. Heredity is more commonly observed when a woman is the sufferer.

Symptoms.—The onset is almost invariably gradual, though cases of sudden onset after many hours' continuous writing have been recorded. The first symptom in writer's cramp is usually spasm of the thumb or index finger while writing, so that the pen is not guided quite properly, unintentional strokes are made, or the pen may be dropped or driven into the paper. The writing thus becomes jerky and illegible, owing to the fingers and thumb gripping the pen too forcibly, and the pen slipping between the first and second fingers. The writing becomes slower and more and more of an effort, and sooner or later pain is noticed either in the finger or thumb, or in the front of the wrist or forearm. This pain, which sometimes is the initial symptom, is aching in character, and is excited at first only by the particular movements that are affected, as in writing, but later, if the writing or other handicraft be persisted in, the pain and spasm may affect other movements, or sometimes the pain alone may extend and affect almost every movement of the arm. Tenderness of the nerves in places is common, and tremor may occasionally be very marked. In one case of hammerman's cramp that I have met with, the tremor was so persistent and extensive in the affected hand and forearm as to suggest at first the diagnosis of paralysis agitans. Other sensory symptoms may be tingling or formication of the hand and even of the leg on the same side. Hyperæsthesia of one side and hemianæsthesia of functional type have also been met with. Weakness without spasm of the particular movements involved may be rarely met with, and thus Gowers distinguishes four forms, the spastic, tremulous, neuralgic, and paralytic, though almost invariably two or more of these are combined. In a case of old-standing writer's cramp, weakness in addition to spasm and pain may extend to other movements, though in early and typical cases of the disease no weakness whatever of the muscles involved in the writing spasm can be detected, except in the particular movements of manipulating the pen. These muscles are especially the opponens and abductor pollicis and the first and second dorsal interossei. The electrical reactions of these muscles usually show no change early in the course of the affection, though later on, at first hyperexcitability to both currents, followed by slight diminution of reaction to both faradism and galvanism, and slight sluggishness of contraction may be noticed. Later still, some wasting of the affected muscles is sometimes seen, though any marked wasting is strongly suggestive of some organic disease such as neuritis or poliomyelitis. The disease in its course shows a marked tendency to gradual spread and increase of the symptoms so long as the faulty method of writing is persisted in, and especially if prolonged spells of writing have to be done. Even correction of the mode of writing and altering the pose of arm and the shape of the pen are usually insufficient to effect a cure unless the cardinal point of rest is also assured. If writing with the left hand be essayed as a means of resting the right hand, the spasm may in time spread to the left side, or other movements may develop spasm, such as in playing the piano or in sewing.

Other Occupation Neuroses.—Pianoforte players are apt to develop cramp in the extensors of the wrist and fingers from the somewhat strained position taught in some schools. Violin players may develop cramp in either the bow hand, or in the flexors of the left wrist and fingers. Telegraphist's cramp is rare, and occurs only in users of the Morse instrument, from the repeated flexion and extension of the finger required to depress the key in marking the dots and dashes. Haircutter's cramp I have met only one example of, and inquiries amongst the operatives in large hairdressing saloons have always elicited the reply that it is unknown. Ballet dancers get cramp in the gastrocnemius and long flexors of the toes, from the great strain in keeping the weight of the body poised for long periods on the points of the toes. Cramp of the flexors of the wrist and thenar muscles I have met with in a gentleman devoted to piquet, from the constant sustained effort in holding the cards fanwise in the left hand. Miner's and mountaineer's nystagmus is a peculiar affection produced by the constant strained position of the eyes, as in coalminers who have to lie on one side in holing out the coal, necessitating the eyes being constantly directed to one side. The predominant symptom in these cases is not spasm of the eye muscles, but tremor or inco-ordination, which may be so violent when the eyes are turned in the direction in which the eyes were originally strained, as to cause objects to dance before the patient's eyes. Hammerman's cramp, smith's palsy, or hephæstic hemiplegia, as it was originally named by Dr. Frank-Smith in 1869, occurs in men who are constantly wielding hammers varying in weight from two to seven pounds, forgemen and nailmakers. Since there must be many thousand recurring contractions of the shoulder and arm muscles daily in these men, as they work by piecework, it is easily conceivable that a fatigue cramp analogous to writer's cramp might be set up. Most of the recorded cases, however, are distinct cases of hemiplegia, of sudden onset, and undoubtedly due to an actual brain lesion. Some are more typical, with gradual onset, the arm being first held close to the side, so as to fix the scapula and rest the serratus magnus. All the usual characteristic symptoms may be met with—spasm, pain, tremor, and weakness. In one of my two cases tremor was the predominant symptom, being so severe as to suggest at first paralysis agitans. In the other case there was pain referred to the bend of the elbow on clenching the fist, as in the act of grasping the hammer, apparently so severe that he could scarcely exert any pressure with the hand. There was also marked weakness of the triceps in extending the forearm, as in the act of striking with the hammer, while the power of the muscle was quite good in keeping the arm out straight when already placed in that position. This inconsistency in the strength of the muscle is a proof of the weakness being functional, and not due to any organic lesion. In addition to the weakness of his arm, his right leg was weak, and dragged in walking, apparently resembling Dr. Smith's cases, but in addition there was marked right hemianæsthesia with slight contraction of the right visual field, and diminution of hearing, taste, and smell on the right side. These symptoms persisted for four or five months under treatment by faradism, but they gradually disappeared, and he made a perfect recovery, and returned to his work.

Pathology.—Three views have been put forward: (1) that there is a local weakness of the muscles; (2) that the spasm is set up reflexly by sensory impressions received from the part in question; (3) that the disease is central in origin, due to exhaustion and inco-ordination of the centres in the brain, a neurosis.

The first theory has been strongly advocated by Poore, who claims that there is often some wasting of muscle, and more often electrical changes in the muscles, and that the weakness is not always limited to the particular movement involved. Against this is to be set the undoubted fact that in early cases there is often no trace of wasting or of electrical change, and that the disability is purely limited to the particular movement, as in writer's cramp. Again, weakness of those muscles due to a neuritis or poliomyelitis does not cause any spasm on movement, and the spasm in writer's cramp is often far wider than the antagonists of the weak muscles. The weakness is certainly not primary; the electrical changes are late, and the wasting later still. Nor can the explanation be a reflex spasm set up by sensory stimuli, because there is no obvious sensory stimulus as an initial symptom, pain being sometimes absent for months after the spasm has become well marked. The pain is neuralgic in character, and is due to a morbid over-action of the sensory centres, the nerve tenderness being similarly neuralgic, and not due to any neuritis. The pain, when established, no doubt helps in the vicious circle of developing the spasm, just as the pain from a sprain or local periostitis may act as the exciting cause in the development of one of the occupation neuroses. The true pathology of these affections is no doubt to be referred to the central nervous system, that the disease is a neurosis, brought about by overwork of the co-ordinating centres in the brain whereby the movements are effected, the lines of resistance being so lowered that at last the movement becomes practically mechanical, and scarcely requires any thought. When this stage is reached, too constant and prolonged drafts on the liberation of nerve energy of these centres is apt to induce spasmodic overflow of the explosions of nerve force into neighbouring centres, whereby muscular spasm and tremor, with weakness of the particular movement, are the result. Later, the same process may spread to neighbouring sensory centres, producing pain referred to the affected part and areas of local tenderness. Impairment of function is, as Gowers says, likely to be accompanied by impairment of nutrition, and with disordered nutrition of the cortical cells some wasting is not unlikely, with diminution of electric irritability to both currents, as is frequently seen in many cases of hemiplegia. Such wasting is therefore secondary, and is not to be looked on as the cause of the trouble. The fact that it is never in the learning stage, which is often long and painful as in writing, that writer's cramp is developed, is strongly in favour of the theory last put forward, and against that which would ascribe the trouble to a local muscular weakness, which would be more likely to be produced during the laborious stage of the acquirement of the art. The muscles are more easily fatigued then than afterwards, when by frequent use their nutrition is improved, and prolonged efforts are better borne. The fact that writer's cramp is apt soon to attack the left hand if persistently used when the right hand has been already similarly disabled, is a convincing argument against the peripheral theory of the disease. The neurosis theory could scarcely be doubted in the case of the hammerman mentioned above, who, in addition to hammerman's cramp, had a typical functional right hemiplegia, the whole clearing up completely after persistent faradic treatment.

Diagnosis.—This is generally obvious in the case of writer's cramp, and is less likely to be overlooked than to be suggested when there is commencing organic disease affecting the hand, as paralysis agitans or the gradual onset of hemiplegia. In two recent cases I have seen of syringomelia, with muscular wasting and pain in the upper extremity, in each case writer's cramp was the first suggested explanation of the symptoms, one of them a man engaged in the account department of a large newspaper office, and having many hours' writing to do daily. In his case the intrinsic hand muscles were wasting. The other case was a laundry woman who wrote very little, and that with no great facility, but whose first symptoms were cramp in the right hand and pain when writing, ceasing on stopping writing. No atrophy of the hand muscles occurred in her case, the wasting being limited to the upper arm and trapezius, though the analgesia was present only on the hands and lower part of the forearms. Before making the diagnosis of writer's cramp, it is therefore necessary to carefully examine for any signs of organic disease, such as neuritis, slight hemiplegia, or spinal disease. Rheumatoid arthritis, chronic rheumatism, or gout might similarly cause disability in writing. As a general rule, if the weakness and spasm are limited to the act of writing, and to that alone, the diagnosis of writer's cramp is clear, though, it is true, exceptions to this rule may be occasionally met with, as in the case of the laundry woman already referred to.

Slight fatigue after writing is liable to be confounded with true writer's cramp, especially in nervous people who have seen or read of the disorder

The absence of true spasm in these cases will generally give the required clue. Other occupation neuroses are perhaps more liable to be overlooked, though in these cases also the occurrence of the symptoms only during some particular act, while the limb is practially free from weakness or spasm in all other movements, will decide the diagnosis.

Prognosis.—If treatment is begun early, and rest from writing or from any other occupation that is at fault can be assured, recovery is most probable. The probability of recovery from writer's cramp is greater in those cases in which other causes but excessive writing have contributed to its development, such as local injury, mental anxiety, or other debilitating illness—causes, that is, that are removable; and the same reasoning applies to the other occupation neuroses. If the disease has become fully developed, and especially if pain be a prominent feature, recovery is less likely and more tedious. The most unfavourable cases of writer's cramp are those in which the hours of writing are long, and rest is an impossibility owing to the dependence on the employment for a livelihood. Recurrence in the left hand sometimes follows if that is used in place of the right, especially, according to Gowers, when neuralgic pain is the predominant feature.

Treatment.—As already said, rest is an essential part of the treatment, though much may be done in improving the general condition by tonics, iron, and strychnine, change of air and scene, and avoidance of all mental worry. Since, in writer's cramp, a faulty method of writing is largely the cause of the neurosis, in the early stages of the disorder the symptom may be arrested by attention to this. A thick cork penholder should be substituted for the ordinary penholder or quill, the kind of nib matters little so long as it will glide easily over the paper, and the pen must be held about its middle, so that the end of the middle finger is at least one and a half inches distant from the point of the pen. Some patients find some relief by holding the pen between the first and second fingers, though this is not to be generally recommended. The act of writing must be performed from the shoulder in as free a manner as possible, the fingers, wrist, and thumb being held quite motionless, so that a line may be written across a sheet of notepaper without taking the point of the pen off the paper. In order to take as much strain off the arm as possible, it is a good plan to have the front of the writing table curved deeply so as to fit closely around the body, in order that the elbow may rest on the table. The surface of the table should be well polished, so that the elbow may glide easily in this method of writing from the shoulder. Another way of compassing the same end may be obtained by sitting sideways at an ordinary table, so that the right arm may rest upon it. If, as soon as the symptoms are first noticed, three weeks or a month's complete rest from writing can be obtained, and then when the occupation is again resumed, the style be corrected as above, a cure may sometimes be effected. Local treatment is also of some value, and the patient should be encouraged to knead the muscles of the thenar eminence and the first dorsal interosseus with the left hand several times a day, and also at the same time to practise flexing and extending the thumb and fingers in all directions for a few minutes two or three times a day. Local galvanism is not of much use, but may be tried if the pain is severe, or if there be wasting. In a severe case writing with the right hand must be entirely given up for six months if possible, and the left hand used in its place. If the writing is of such a kind that it can be done by a typewriter, the use of this may be attended by no discomfort even in a bad case of writer's cramp, and the left hand may be used alone if pain or spasm is induced in the right. For this purpose the Yost machine is to be preferred to the

Remington, on account of the upper case for the capitals being worked by a different set of keys from those for the small letters, thus necessitating a freer and less cramped movement of the hands. What has been said for writer's cramp applies generally to all other occupation neuroses, rest from the harmful employment being the first essential. If definite evidence of functional weakness or anæsthesia be found in addition, these may be combatted by energetic faradism and massage.

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New-born Infant.

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DEFINITION.—The term "new-born" is applied to the infant during the first month of his post-natal existence. There has been life already, during the ante-natal period—the life, however, has been of a semi-parasitic kind, dependent upon that of the mother; but after birth the life of the child may go on independently of that of the mother so long as there is someone to care for it and supply the wants that are peculiar to it. While the mother is passing through the puerperal period of life her infant is passing through the neonatal, and in both periods there are most interesting changes going on which are largely of the nature of readjustment of function—changes which leave their impress upon the diseases of these epochs and necessitate special treatment and management.

Anatomical Peculiarities.—The new-born infant is not the adult in miniature; the changes which occur during the passage from the infantile to the adult state are not simply increases in size of the body, its parts, and its organs. There is, it is true, an increase in size of many parts and viscera; but it is not in proportion, and some organs which were relatively large in the infant are relatively small in the adult. There are, therefore, anatomical peculiarities in the new-born infant, and, in a phrase, these may be described as conditions resembling, on the one hand, the anatomy of the fœtus, and on the other that of the child and adult. The anatomy of the neonatus is a transitional anatomy (1).[1]

In the relative size of the various regions of the body the new-born resembles the fœtus rather than the adult. As compared with the child or adult the infantile head is relatively large, and the infantile limbs are relatively small; further, the cranium is relatively larger than the face, and the upper limbs than the lower; and both the thorax and the pelvis are relatively smaller than the abdomen. The viscera show the same peculiarity: the liver is relatively large, and, compared with the right, the left lobe is large out of the adult proportion; the thymus gland, cerebrum, and the supra-renal capsules are disproportionately large, while the stomach and cerebellum are small; the body of the uterus is small, while the cervix and the vagina are large; and as regards the regions of the spinal column, it may be said that in the infant the cervical is nearly, if not quite, as long as the lumbar, while in the adult it is in the proportion of 2 to 3.

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[1] Figures in brackets refer to literature at end of article.

In their relations to each other the parts and organs of the body of the infant also show peculiarities. The hyoid, for instance, lies opposite the axis vertebra (1) instead of opposite the fourth or fifth cervical vertebra, as in the adult. The larynx also is about two vertebral bodies higher in the neck, and the bifurcation of the trachea is one vertebra higher than in the adult. The heart is situated more transversely in the thorax, and at a little higher level in relation to the spine; the apex is farther to the left and higher in the infant, corresponding often with the nipple. With the establishment of respiration the lungs, which have been lying at the back of the thorax, come forwards, and the left one insinuates itself between the heart and the anterior chest wall; the presence of the large thymus in front of the heart prevents the close approximation of the lungs to each other save in their upper portions. In the infant at birth the stomach lies entirely under cover of the left lobe of the liver, but as the digestive functions are established, it emerges gradually from under the hepatic border. The umbilicus at this time in life is situated nearly equally distant from the feet and the vertex, but a little nearer the feet; in later childhood it corresponds with the symphysis pubis. The relatively large size of the liver increases its relations with other abdominal organs, and it comes, for instance, into contact, with the surface of the spleen; the spleen also has a contact relation with the left adrenal. The relations of the intestines are often ill-defined at birth, and anomalies are met with; but it is fairly common to find a loop of the sigmoid flexure in the pelvis in male infants. The urinary bladder is an abdominal organ in the infant, and between its anterior surface and the abdominal wall there is no intervening pouch of peritoneum. In the female, also, the greater part of the uterus and the tubes and ovaries lie above the plane of the pelvic brim.

The form of several of the infantile organs exhibits peculiarities. The liver, for example, as has been shown by the frozen sectional method, possesses six surfaces—a superior, left inferior, anterior, posterior, right, and left; the left surface is due to the large size of the left lobe. The stomach has a relatively small fundus, and the lesser curvature forms a more acute angle than in the adult organ. The kidneys show traces of lobulation, a fœtal character; and the supra-renal capsules have much more distinctly, than in adult life, the pyramidal shape.

There are yet other anatomical peculiarities which are found in the infant at birth. In the heart, for instance, the foramen ovale and the ductus arteriosus, which are open in the fœtus and at birth, close during the first month of life; probably both are physiologically closed within a few minutes of birth, although they may be anatomically pervious for some weeks later. The same statement may be applied to the ductus venosus in the liver. In the cheek of the new-born there is an encapsulated mass of fat, the so-called "sucking pad." The rectum is large, more vertically placed, and more nearly a straight portion of the intestine than in the adult. In the skeleton, also, there are numerous peculiarities due to the incomplete stage of ossification which has been reached. The cranial vault bones, for instance, have not yet united along the lines of the sutures, and at six points a considerable membranous interval intervenes between the adjacent bones; these membranous intervals are known as fontanelles, and are distinguished as anterior (which is large, quadrangular, and has four sutures running into it), posterior (which is much smaller, triangular, with three sutures running into it), and four less important lateral fontanelles. Some of the long bones only, as the femur, show centres of ossification in their epiphyses. The ramus of the lower jaw makes with the body of that bone a more oblique angle than in the child; and the auditory meatus is imperfectly developed at birth. The segments of the sacrum and coccyx are not fused together into one bone in the new-born infant; and the spinal column has not yet any fixed curves.

Physiological Peculiarities.—The physiology of the new-born infant, like its anatomy, is transitional in its character: it resembles in many details the physiology of the child and adult, but it also shows evident traces of the functional peculiarities of the fœtus. Birth is the more or less traumatic transition from an existence in the fluid medium of constant or nearly constant temperature, in the dark, and protected from external violence, into a life in an atmospheric medium of a temperature lower than that of the body, in the light, and with no natural protection from injury. Birth, therefore, entails readjustment of function; and readjustment of function is a leading character of the physiology of the new-born infant. Further, neonatal physiology has peculiarities impressed upon it by the fact that during the first few days of life the infant is recovering from the effects of its passage through the maternal birth-canals, a process often truly traumatic. The circulation of the new-born, for instance, shows this readjustment. With the ligaturing of the cord the placental circulation stops and the pulmonary becomes more fully established, a change accompanied by the physiological closure of the ductus arteriosus, the foramen ovale, and the vessels connected with the umbilical circulation. The pulse-rate, which has been from 130 to 140 beats per minute in fœtal life, remains high, but not quite so high as before birth, varying from 120 to 140; the rate is little affected by posture. The arterial tension is said to be low, for the width of the aorta is greater in comparison with the volume of the heart than in later infancy. It has often been stated that sphygmograms of the new-born infant's pulse simply consist of slightly undulating lines; but this statement does not always hold, for Dr. H. Oliphant Nicholson has taken tracings from infants less than a week old in which there was not only a sharp apex, but also distinct tidal and dicrotic wavelets (13). The pulse-rate is to the respiration rate as $3\frac{1}{2}$ or 4 : 1. The composition of the blood of the new-born also shows transitional characters. It contains a higher percentage of hæmoglobin; in five infants examined by Carstanjen (3) it remained above 100° till after the twelfth day of life. It contains a large number of red blood corpuscles in the cubic millimetre (6 to 7 millions); this character holds for the first four or five days, as does also the presence of some nucleated red cells (till the third day according to Carstanjen). It has a greater coagulability, and shows marked leucocytosis. The leucocytes are of several kinds; at first the polynucleated ones are most numerous; after the first twenty-four hours the lymphocytes increase in number, and become equal to the polynucleated leucocytes about the sixth day; transitional forms are also specially numerous between the sixth and ninth days; eosinophilic cells are not markedly numerous.

The pulmonary respiration of the new-born is not usually established fully till the infant has been expelled from the maternal passages and the cord tied and cut, and for some days afterwards the lungs are not completely expanded in every part. It is excited to begin partly by the venous condition of the blood due to the stoppage of the placental circulation and partly by cutaneous stimulation. It is chiefly abdominal in type, and has a rate of from 30 to 50 respirations per minute, but it has a tendency to be irregular in rate and variable in character. Although urine may be secreted in fœtal life, and may even be expelled into the liquor amnii, usually it is not till after birth that it comes to be secreted with the regularity of a function and expelled periodically from the bladder. Micturition in the new-born infant is quite involuntary, and occurs from six to twenty times in the twenty-four hours. The urine is colourless, as may be learned from the fact that it leaves no stain on the diapers; it is odourless, has a low specific gravity, an acid reaction, and not infrequently contains albumin during the first few days of life. Uric acid is always present, but urea is absent or in small amount. In fœtal life the sebaceous glands of the skin secrete freely, with the result that at birth the infant is covered with a greasy coating, the vernix caseosa, which consists largely of sebum mixed with epidermic scales and lanugo hairs; after birth the sebaceous glands continue to be active, but the sudoriparous do not secrete much if at all for some time. A fine desquamation of the cuticle takes place during the first week of neonatal life, and the colour of the skin is often yellow (physiological jaundice of the new-born). The mammary glands in both the male and the female infant are frequently active soon after birth, and in consequence a little milky fluid may be squeezed out. The temperature at birth is a little above that which is normal for the child and adult, being 99° F.; and it remains at that level for the first week under healthy conditions; but it is well to remember the great tendency that exists in new-born, and especially in prematurely born infants to chilling of the body.

Rapid increase in size and weight is characteristic of the fœtus in utero, and this character is retained by the new-born infant, but in less degree. In this respect also transition is to be noted. Weighing about seven and a half pounds (3000 grms.) at birth, the new-born loses about 200 grms. during the first two days, regains its original birth-weight about the fifth day, and thereafter increases in weight at about the rate of 26 grms. a day for the remainder of the first month. This may be contrasted with the daily increase at the end of the first year, viz. from 5 to 10 grms. The length of the new-born is from 19½ to 20 inches (49 to 50 cms.), and during the first month this is added to to the extent of 3 inches (7·5 cms.); the whole body does not grow at an equal rate, the greatest rapidity being shown by the lower limbs. During intra-uterine existence the physiology of the nervous system almost entirely consists in the performance of reflex actions by the spinal cord, the cerebral centres being largely quiescent; after birth the spinal cord continues to functionate, and the cerebrum and higher centres begin to awake to activity slowly. Voluntary movements do not occur in the first month of life, the movements that are seen are either reflex or instinctive. The plantar reflex usually shows itself in extension of the toes, when it takes the form of flexion it is commonly in infants whose birth has been instrumental or otherwise abnormal, as has been demonstrated by Finizio (2). The patellar, like the plantar reflex, is almost constantly met with in the new-born; but some others, and especially the cremasteric, are often absent. The special senses of sight, hearing, smell, and taste are in operation within a few days of birth, the sense of taste in all probability being the first to be developed; by them the infant has perceptions or rather "recepts." The sense of touch is already present at birth.

The activity of the digestive organs, like that of the respiratory organs, begins at birth, for it is improbable that any marked functioning of the buccal, gastric, or intestinal glands occurs in utero. Even at birth, and for some six or seven months later, the food is little altered in the mouth; very little saliva is secreted, and only that coming from the parotids has a diastatic action. The gastric glands are, however, quite capable of fully digesting human milk, although there is some doubt as to the exact chemistry of the process; some digestion of starch can also be accomplished in the stomach of the new-born, but it is small in amount and not to be relied upon. The hepatic secretion of bile is established at birth, for the gall-bladder is often found distended in infants dying at or soon after their expulsion from the uterus; but the bile is poor in its characteristic constituents, with the exception of the bile pigments. The secretion of the pancreas in the new-born is effective in forming peptones and in emulsifying fat, but its action on starch is very limited. The new-born infant has normally from three to four stools daily; for three or four days the fæces consist of the greenish-black meconium made up of the intestinal contents of fœtal life, and destitute at first of putrefactive products and of bacteria; thereafter the motions are pale yellow or orange in colour, have a soupy consistence, and are composed of digested milk from which the nutritive constituents have been removed by absorption.

Management of the New-Born Infant.—The hygiene of the new-born has peculiarities which depend upon the transitional state of its physiology, and upon the fact that the organism has just passed from an intra-uterine to an extra-uterine environment. There are two great governing principles, viz. to keep up the body heat and to make no further call upon the organs in their imperfectly developed state than they can reply to.

Immediately after birth the child is to be drawn from under the bedclothes and turned upon the right side with the back towards the mother's genitals; it will then usually begin to cry loudly, and attention may be turned to the ligation of the umbilical cord. The root of the cord should be first inspected to note that it is free from a loop of intestine which sometimes is found protruding into it; then a sterilised ligature of elastic tape, or of thin silk threads (in the form of a skein) is applied to the cord, about two finger-breadths from the abdominal wall, and tied tightly; a second ligature of the same material is attached on the distal side of the first; and the cord is divided between the two by means of a pair of probe-pointed sharp-edged scissors which shall have been sterilised. Recently other methods of treating the umbilical cord have been recommended, but have not yet been widely adopted; amongst these are omphalotripsy (4), which consists in the compression of the root of the cord with strong forceps (omphalotribe), and the primary amputation method of Dickinson (5). The cut end should be examined to see that there is no bleeding from the vessels, washed with some weak carbolic lotion, and dressed with wood wool or iodoform gauze. In the first place, however, the infant has to be bathed. For this purpose the nurse takes her place in front of an open fire with the child on her lap. The child she has taken from the medical attendant in a warm flannel wrapper, using care that it be not allowed to fall through her hands by reason of its slipperiness. The common practice of squeezing the breasts to break the breast-strings must be absolutely forbidden. The eyes are first carefully washed, and if there has been a maternal vaginal discharge (gonorrhœal or otherwise) during pregnancy it will be necessary to instil into each conjunctival sac a drop or two of a 1 per cent solution of nitrate of silver, or simply of boiled water or saline solution. Then the mouth is to be washed out with clean water. The cleansing of the head and body often takes some time on account of the adhesive vernix caseosa; it is best removed by means of vaseline or a little clean lard; it ought to be rubbed off briskly, beginning at the head and paying special attention to the flexures of the neck and limbs. The infant is then put into a warm bath and cleansed with soap and water; thereafter it is to be dried lying in the nurse's lap, and it is customary to dust some powder, such as fuller's earth, bismuth, or talc into the folds of the skin and around the orifices. Then the cord is wrapped round with antiseptic gauze, and in order to keep it in position a flannel binder is applied twice round the abdomen and fixed by stitching. The rest of the infant's clothing consists of a cambric shirt, a long flannel underdress supported from the shoulders by tapes, and an overdress with long sleeves either of flannel or muslin; there should be a diaper of warm towelling held in position by a flannel binder, and the feet should be protected by woollen socks, and the head by a shawl. The infant will then in all probability fall asleep, and should be placed in his crib or at any rate in a place of safety where he will not run the risk of injury until the mother is ready to receive him. It may be added that he ought to be carefully inspected to see that he is not the subject of any structural abnormalities.

Feeding.—After the mother has had a sleep the infant ought to be put to the breast; this will usually be about eight hours after labour. The first milk or colostrum acts more as a purgative than as a food for the child, and helps to unload the intestine of the meconium. No other nourishment is generally required until the mammary glands begin to secrete the milk, which will be about twenty-four hours after labour; the secretion will be fully established by the third day. Prior to the commencement of regular lactation the infant's mouth may be washed out with a little boiled water; there is no need to add to it, as is customary, some sugar. In the great majority of cases there is no necessity to supplement the mother's milk with any other food; it contains all the constituents of a perfect food for the organism at this time of life, and these constituents are in perfect combination amounts. At first the infant will be put to the breast with the mother in the horizontal posture, and about the end of the first week she will be able to nurse her child sitting up and leaning slightly forward. She will support the nipple with the index and middle fingers of her disengaged hand so as to control if necessary the flow of milk into the infant's mouth. One breast ought to be used at each lactation, and the breasts should be employed alternately. Regularity in nursing ought to be insisted on from the first, for then habits are easily formed, and much future discomfort may be avoided. During the first week the breast ought to be given every two hours between the hours of 5 A.M. and 11 P.M.; if trained to it at the beginning, most infants will soon learn to sleep continuously, with possibly a changing of diapers once, from 11 P.M. to 5 A.M. From the end of the first week to the end of the neonatal period the nursings should be at intervals of two and a half hours. The infant takes from one and a half to two ounces at each meal, and a total of twelve to sixteen ounces in the twenty-four hours. The breast should not be given simply for the purpose of stopping crying; sometimes the infant cries from hunger, then the cry is strong, and occurs after a period of time has elapsed since the last meal; but in many cases the crying is due to colic, and is accompanied by convulsive movements of the limbs, and then frequent nursing exaggerates the colic and stops the crying only for a few minutes. In order that the mother may have a sufficient supply of milk for her infant it will be necessary for her to take large quantities of milk herself along with strong animal soups and cocoa and gruel; she ought also to have abundant time for rest and sleep, and should be free from household and other worries. Alcohol is an unnecessary part of her diet, unless she have been in the habit of always taking it. The nipples should be carefully washed before and after each nursing.

If the normal or *maternal* method of infant feeding be impossible (by reason of physical disability of the mother, or on account of serious illness, or because the child has been expelled from the uterus prematurely before the mother's mammary glands are prepared to functionate), then a wet-nurse must be employed, or artificial feeding resorted to. Theoretically the *wet-nursing* or *mercenary* method stands next in value to the normal or maternal, for the infant is being supplied with human milk, albeit the milk of another woman than the mother; but in actual practice there are many difficulties and inconveniences which conspire to make the method one which is seldom employed. There is the matter of expense; the wet-nurse who is both healthy and of irreproachable morals is a rara avis; and household arrangements are apt to be seriously upset by the presence of any save a most exemplary wet-nurse. Still, in certain cases, as with a premature and weakly infant, and in some forms of infantile diarrhœa, wet-nursing may save the life of the child. Alcoholism and syphilis in the wet-nurse must be excluded, and she ought not to be the subject of tubercle or of epilepsy; she should be neither pregnant nor menstruating; she should be between the years of 25 and 35, and if possible she should be married, or if unmarried she ought not to have had more than one pregnancy. It may be determined roughly that her health is good and her milk in a satisfactory state by inspecting her own baby; if it be well nourished and free from disease, it may safely be concluded that she may be trusted with the care of another woman's infant. In most cases, however, if the new-born infant cannot be nursed by the mother, it has to be brought up *artificially, i.e.* bottle-fed. Although cow's milk does not approximate so closely to human milk in its composition as does the milk of the ass, it is yet found that practically it makes the best substitute for it. For the new-born infant it becomes a matter of the greatest importance that the milk of the cow be made as similar as possible in composition and in digestibility to human milk, and be as free from microbic and other impurities as is the fluid drawn from the mother's breast. In order to carry out these requirements the following preparation of it is necessary. In chemical composition cow's milk contains more nitrogenous material or albuminoids than does mother's milk; it is therefore customary in order to correct this to add water, an equal part, to bring down the excess of albuminoids. Cow's milk also contains less sugar and less fat than mother's, and the addition of water has still further reduced the proportion of these constituents, so that it will now be necessary to add cream and sugar (lactose or cane sugar) to adjust the composition. Further, there is a physiological difference between cow's milk and human milk in that the casein of the former when acted upon by the gastric juice of the infant forms a much firmer and less digestible curd than does that of the latter; this difference is corrected, and the casein-curd is rendered loose and more flocculent by the addition of an alkali such as lime water, or of a mucilaginous material such as barley water. These various requirements are met satisfactorily in such a preparation as Meigs' cream mixture, which consists of cream 2 oz., milk 1 oz., lime water 2 oz., and sugar water 3 oz. The sugar water contains 2¼ oz. of milk sugar in a pint of water. As prescribed above, the mixture will be sufficient for four meals for a new-born infant. There are, however, other difficulties in the way of suiting cow's milk to an infant's needs. There is, for instance, the prevention of the entrance of impurities into the milk on its way from the cow to the nursery, and after its arrival in the nursery. To begin with, the cow should be healthy, should at any rate not be tubercular; the attendants in the byre and dairy should be free from all infectious diseases such as scarlet fever and diphtheria; and all the vessels in which the milk is placed should be kept scrupulously clean. As it is found almost impossible in practice to be sure that all these conditions have been obtained, it has become a frequent practice to sterilise the milk and so render innocuous any germs of disease which may have gained access to it. This may be done in a rough and ready fashion by boiling the milk, but it is better to use one of the sterilisers, such as Soxhlet's or Arnold's, in which the milk in bottles closed with cotton wool plugs is subjected to the influence of steam for half an hour or three-quarters; it will thereafter keep for a long time, and if kept in stoppered bottles need only be heated up when required for use. With regard to the bottles in which the milk is given to the infant, the principles which guide us ought to be to obtain a plain flint glass boat-shaped bottle, without projections or irregularities such as would render it difficult of being kept clean, and to use in connection with it no long india-rubber tube, but a simple rubber teat which can be easily inverted for cleansing purposes. Wende (6) has recently given an alarming bacteriological demonstration of the dangers which lurk in the long rubber tubes which used to be so frequently employed in connection with feeding bottles; and there can be no doubt that the whole apparatus used in infant feeding ought to be as simple and as easily cleaned as possible.

By the methods which have been detailed above it is usually possible to provide a satisfactory substitute for human milk, although it is probable, as has been pointed out by Bartley (7) and others, that there are subtle chemical differences between the milk of the cow and that of the woman which cannot be perfectly adjusted. When, however, the infant to be fed is weakly or premature, then these unadjusted differences make their influence felt, and persistent indigestion, gastric or intestinal, or both, is the result. Under such circumstances peptonised cow's milk will sometimes be successful: three grains of Benger's peptonising powder are to be added to two ounces of milk and two ounces of boiling water, the mixture is to be allowed to stand for ten minutes, and then half an ounce of cream and a pinch of sugar are to be added. The various much-advertised infants' foods, containing starch and large quantities of sugar, are seldom, if ever, to be given to the new-born infant, although they find a sphere of usefulness in connection with children of more than six months. If all means of feeding the infant artificially fail, and gastro-enteritis threaten life, the last resort will be wet-nursing.

It ought to be added that the mixed method of feeding the new-born will often give better results than the artificial alone does. That is to say, when the mother is able to nurse partially, even if it be only three or four feedings in the twenty-four hours, the infant will have a better chance of thriving than if brought up entirely by hand.

When the infant is about five days old the stump of the umbilical cord usually drops off; a granulating surface is left, which skins over and is retracted. The separation of the stump is due to mummification of the tissues and necrosis at the base. An infant should be bathed once a day in front of a warm fire, the water having a temperature of 92°, as determined by a bath thermometer. Premature or weakly infants need only be sponged in the nurse's lap. In summer the infant may be taken into the open air when a fortnight old, being carried on the nurse's arm, and kept in the sun. He should sleep in a crib, and not in the bed with either the mother or the nurse.

Pathology of the New-born Infant.—Several of the diseases which affect the new-born have characters so distinctive that it has been concluded that they are different in nature and cause from the maladies of the adult; at any rate it has been thought that there is sufficient difference to justify the addition of the word "neonatorum" to the name of the affection, *e.g.* œdema neonatorum, melæna neonatorum, etc. It is probable, however, that the causes of diseases are the same in the neonatal as in the other periods of life, and that the differences in their manifestations are due to the peculiarities of the anatomy and physiology of the epoch. The various readjustments of functions which are going on immediately after birth must modify pathological processes, and the impress of the traumatism of birth cannot but contribute to the formation of a special pathology of the new-born. It has also to be remembered that before birth morbid causes may have been in action, and that some of the peculiarities of neonatal diseases may be due to ante-natally developed conditions.

Asphyxia neonatorum, apnœa neonatorum, still-birth, or apparent death of the new-born, is a condition of the infant at birth in which there is a stoppage of the functions of animal life, with absence of respiration, and absence, or rather weakness, of cardiac action. A still-born child is not necessarily a dead child, but the condition may pass into death. Two clinical varieties have been commonly recognised, the pale and the livid, or the anæmic and the congestive. In their pathology there is no great difference save in the condition of the cutaneous vessels, which in the former are empty and in the latter engorged with blood. Clinically there are other differences: in the pale form the mouth is open, the lower jaw having fallen, the mucous membranes are pale, the skin is cold, the eyes closed, the anus is relaxed, as are the limbs and the muscles everywhere, and the heart-beats are very feeble or inaudible; in the congestive type the lips are swollen, the eyes are injected and protruding, the mucous membranes are congested, the skin is hot, the limbs are somewhat rigid, the umbilical cord is swollen, the reflexes are preserved, and the pulse is stronger than in the former variety. Asphyxia neonatorum may be due to a great number of causes: it may be due to prematurity and congenital weakness of the infant, to interference with the intra-uterine circulation in the placenta (from separation or disease) or umbilical cord (knots, twists), to compression or other traumatism during delivery, or to temporary pressure upon the cord leading to attempts at respiration while still in the mother's canals, and the consequent inspiration of mucus, meconium, etc., into the air passages. It may also be produced by certain fœtal diseases, such as ascites, which prevent the action of the diaphragm. The prognosis is better in the livid than in the pale form. The treatment consists, in the first place, in an attempt to excite respiration by such ordinary means as the removal of mucus from the back of the mouth and nose, the slapping of the skin of the gluteal regions, and the placing of the infant in hot and cold water alternately. If these measures fail it has been advised to allow some bleeding to take place from the cut end of the umbilical cord in asphyxia livida, and to aspirate some blood from the placenta to the infant by drawing the cord through the fingers in the direction of the umbilicus before ligaturing it in asphyxia pallida. If the apnœa still continue it will be necessary to have recourse to one or other of the methods of artificial respiration. Of these the most generally employed at the present time is that of swinging the infant recommended by Schultze: the child is grasped by the operator with both hands, the thumbs resting against the thorax, an index finger in each axilla, the other fingers across the back, and the occiput supported by the balls of the thumbs; it is then suspended vertically feet downwards, with the face looking forwards, in which position the chest is opened; it is then swung upwards towards one of the operator's shoulders, when it is found that the infant's head is the lowest point, and that its body has fallen forwards towards the face, thus compressing the thorax and closing the chest. This procedure is repeated some thirty times a minute in order to imitate infantile respiration, and it very often succeeds in causing air to pass freely into and out of the lungs. It has been objected that in the performance of the swinging movements the clavicle of the infant may be broken and may wound the pleura, and cases have been reported in which this accident would seem to have occurred; but with due care the mishap must be very rare. In other cases Marshall Hall's "ready method" of exciting respiration, or Sylvester's plan may be tried (*vide* article on "Respiration of the apparently Drowned"). Howard's method is that in which the infant is placed upon the obstetrician's left arm, lying upon its back and with the head hanging slightly downwards, the operator compresses the thorax and abdomen about twenty times a minute with his right hand, and in this way respiration may be initiated. Another method is to place the asphyxiated infant upon its back upon the palms of the operator's hands held out before him; the palms are then approximated, and the breech and head of the child brought nearer together, and the chest compressed; and then the hands are again put in the position they originally occupied, and the chest opened up (Byrd's method). Laborde's procedure of rhythmic traction upon the tongue has lately been highly spoken of; more particularly in France; it consists in drawing out the tongue with a pair of forceps about twenty or thirty times a minute. Finally, it has been recommended to insufflate air into the lungs by means of a flexible catheter or special tracheal tube (Ribemont-Dessaignes) passed into the larynx. It must not be forgotten that so long as the infant's heart continues to beat there is a chance that resuscitation may be accomplished, and efforts towards this end ought therefore to be continued; marvellous cases of restoration, even some hours after birth, have been put on record. It ought also to be borne in mind that it is necessary to keep the child warm during the efforts at resuscitation, and that even after they have been successful the infant will require watching for some hours.

Affections of the Umbilicus.—In the new-born infant the umbilicus is for some days a possible and indeed a common avenue of entrance for pathogenic germs, and in consequence it is a usual circumstance to find several of the diseases of the new-born localised in the umbilicus or in the immediately neighbouring parts. Further, recent observations by Audion (8) have shown that the umbilicus itself may remain apparently healthy, and yet its vessels may be pervious, and germs pass through them to parts (*e.g.* the heart) distant from the navel, and set up pathological processes there. So that for many reasons the disorders of the umbilicus are of great importance.

Umbilical Hæmorrhage.—Hæmorrhage from the umbilicus may take place soon after the birth of the infant; it is then from the stump of the cord, and is due either to slipping of the ligature or to tightness of the binder, and it is generally checked by loosening the binder and applying a new ligature to the cord. The more distinctive hæmorrhage, however, and the more dangerous, is that which occurs some days later at the time when the stump of the cord is separating, or just after it has separated; this is true omphalorrhagia. It is more frequent in males than in females, and usually appears between the fifth and seventh days after birth. Its pathology is uncertain, but changes in the umbilical vessels have been described (arteritis, phlebitis), and in the blood a diplobacillus, staphylococci, and streptococci have been discovered; it has been ascribed to hæmophilia, syphilis, and to sepsis. The first signs of the hæmorrhage are usually the soaking of the clothes with blood and the anæmic appearance of the infant. There may also be jaundice and purpuric spots. The blood oozes from the umbilical depression, and there may be several clots covering it. Many of the cases perish, and death may occur in three hours, but is more commonly delayed for two or three days. The treatment requires to be energetic in most cases: the umbilicus may be swabbed with styptics, such as perchloride of iron, but usually it will be necessary to apply a mass ligature to the umbilical tissues after having transfixed them with two needles. It has even been recommended that the abdomen be opened, and the umbilical vessels tied separately on the inside; in fact, all sorts of devices have been resorted to, so persistent has the bleeding been. Constitutional treatment, *e.g.* antisyphilitic, must not be forgotten.

Umbilical Infections.—At the time when the stump of the cord is separating, the umbilicus may become infected by the germs which are to be found in the neighbourhood, and through the lymphatics the infection may pass to any or all the adjacent structures. One of the least marked degrees of this infection is found in *ulceration* of the cicatrix left by the fall of the cord; the parts do not look unhealthy, but stains of blood and even of pus are to be seen on the binder, and on separating the margins of the umbilicus a small ulcer is discovered, from which the discharge is coming; the condition requires washing with boric lotion and dusting with iodoform powder, for if left untreated it may lead on to weakness of the parts and consequent hernia. In other cases the ulceration has led on to the formation of a "*fungus*" or *granulation* (umbilical "polypus") in the position of the cicatrix: this is a myxomatous growth of a pale reddish colour, rounded in shape, of the size of a pea or of a pin head, which bleeds readily when handled, and which constantly throws off a watery or purulent secretion; there may be some surrounding excoriation, and the little mass may require to be touched with lunar caustic and the umbilicus treated antiseptically; when large the granuloma needs excision after ligature. Sometimes the inflammation spreads to the skin margin surrounding the umbilicus (*periumbilical lymphangitis*); a superficial lymphangitis occurs with some redness, pain, and swelling of the part. The name *omphalitis* or *umbilical phlegmon* has been given to a deeper extension of the inflammation in the neighbourhood of the navel; in it the cellular tissue becomes infected and inflamed, there is considerable swelling, heat, and pain, constitutional symptoms occasionally of great severity may supervene, and there may be a still further extension of the infection (to umbilical vessels or peritoneum). The treatment will take the form of giving free exit to pus and dressing antiseptically. *Erysipelas neonatorum* usually has its origin in infection through the umbilicus. It is generally associated with puerperal fever in the mother, a fact which points to its streptococcic origin; and it is much less common now than it was in the pre-antiseptic and pre-aseptic days of midwifery practice; but when it occurs it is very fatal. The erysipelatous flush appears first in the hypogastric region, generally two or three days after birth, and soon spreads to the genitals, and later to the thighs and more distant parts. There is high fever (102° to 105° F.), the skin becomes dark red, glazed, and œdematous, but sometimes is so firm as not to pit on pressure. Occasionally there are vesicles and even bullæ. The pulse is rapid (150), the respirations shallow and quick; and death follows from exhaustion on the sixth or seventh day of the illness. The treatment will consist in the internal administration of tonics (tinct. ferri perchloridi, quinine) and stimulants; hypodermic injections of anti-streptococcic serum may be tried, and the surface affected should be dressed with antiseptic vaseline. In the worst cases of umbilical affection the inflammation may go on to widespread *ulceration*, and even to *gangrene* of the part; but such occurrences are now very rare. There is still another group of cases in which the infection and inflammation specially affect the umbilical vessels: in these instances the two arteries may be involved (*umbilical arteritis*), or the umbilical vein may be the seat of purulent processes (*umbilical phlebitis*); in arteritis umbilicalis the inflammation extends along the hypogastric arteries to the level of the bladder, and may cause peritonitis and changes in distant organs; in phlebitis umbilicalis the portal vein is soon affected, and jaundice results. It has been shown that in such circumstances endarteritis and endophlebitis are not always secondary to periarteritis and periphlebitis; they may occur as primary conditions (Audion, 8). Premature infants are always more liable to these umbilical infections, for in them the umbilical route of entrance does not so perfectly close nor so quickly.

Among the umbilical infections must now be included *tetanus neonatorum,* formerly one of the most dreaded scourges of infantile life. It is due to the entrance of the tetanus bacillus (bacillus of Nicolaier), through the umbilicus from faulty or absent hygiene. It commonly begins to manifest itself by difficulty in swallowing and rigidity of the facial muscles between the fifth and ninth days after birth. Soon spasms occur which affect all the muscles. The temperature rises, the pulse becomes very rapid, and the action of the respiratory muscles is interfered with, death resulting from such interference or from exhaustion. It is a disease which has been very fatal, and in certain parts of the world it used to cause an enormous infantile mortality. Its real treatment, which is also the real treatment of all umbilical infections, is prophylactic. If the cord be treated aseptically, or if, failing that, antiseptic dressings be afterwards applied to it, the disease may be practically abolished. Of the good effect of such treatment a brilliant example was furnished a few years ago in the island of St. Kilda (9); in that outlying member of the Hebrides the adoption of surgical cleanness and the use of iodoform dressing for the cord practically got rid of tetanus and saved many lives. When the disease has actually set in treatment by chloral hydrate, opium, and calomel has not proved of any great benefit; rectal feeding will be required. *Buhl's disease,* or acute fatty degeneration of the new-born, is a curious neonatal condition which may be due to an infection, but not necessarily to one entering by the umbilical avenue. It is characterised pathologically by parenchymatous inflammation and fatty degeneration and hæmorrhages in the heart, liver, and kidneys; hæmorrhagic foci are also found in other organs. There is cyanosis, difficulty in resuscitation at birth, jaundice later, and generally hæmorrhage from the mouth, umbilical wound, etc., before the case terminates, as it usually does, in death from collapse. *Winckel's disease,* to which the name of *hæmoglobinuria neonatorum, bronzed hæmaturic disease* of the new-born, *renal tubal hæmatia,* and *pernicious icteric cyanosis* have been given, in certain characters resembles Buhl's disease. The names suggest several of the prominent symptoms and pathological appearances. The disease begins to show itself two or three days after birth. Both jaundice and cyanosis are present, and the result is a very deep icteric tinge, which has been described as "bronzed." The cyanosis is best marked in the limbs. Soon there is hæmaturia, the urine having a coffee-coloured appearance; some observers, however, have found indican and not hæmoglobin or hæmatin in the urine. There may also be diarrhœa, the temperature falls, and there is usually death in convulsions, and from collapse in from two to three days. Histologically changes have been found in the composition of the blood and in the renal tubules; in the latter there is a blackish mass made up of degenerated blood corpuscles, some unaltered red cells, and granular material. Microbes have also been described in the tubules. The pathogenesis of the disorder is not understood; it is probably an infection of the blood or of the kidney. No treatment has yet had any success. Of Winckel's twenty-three cases only four recovered.

Dermatitis exfoliativa neonatorum, or Ritter's disease, or keratolysis neonatorum, is a morbid condition, in which the most evident clinical feature is excessive and general desquamation of the cuticle. It is rarely met with before the end of the first week of life, and is common in the second week. It begins suddenly, and four stages have been enumerated, viz. (1) a stage of erythema and exudation; (2) a stage of exfoliation and drying; (3) one of reintegration of the epidermis; and (4) one of sequelæ, *e.g.* boils. Often the whole process is completed without any severe constitutional symptoms; in other instances, however, there may be diarrhœa and pneumonia, and the disease may be followed by a marasmic condition. It was regarded by Ritter as a pyæmic manifestation; other observers have looked upon it as at least pemphigoid, if not an actual form of pemphigus; and yet others have considered it to be a dermatitis due to some external influence. It is probably related in some way to the physiological desquamation of the cuticle of the new-born, of which it appears to be an exaggeration. A fungus with long and thin mycelia has been found in some instances. It has about a 50 per cent mortality; and the treatment so far has been entirely symptomatic, consisting in the protection of the desquamating surfaces, the administration of tonics, and the observance of good hygiene (10).

Melæna neonatorum is rather a symptom of several diseases than a separate morbid entity. Gastro-intestinal hæmorrhage in the new-born, whatever may be its cause, usually shows itself in the discharge of blood from the bowel, more rarely in the form of hæmatemesis. It may occur either in the first three or four days of life, or in the beginning or middle of the second week. It is soon accompanied by the signs of marked anæmia, and icterus is a frequent symptom. A *spurious* form is due to the swallowing of blood which has come from the mother's nipple in lactation. The *true* form has a mortality of from 35 to 60 per cent, and before death there is great coldness of the body, and convulsions often supervene. Its duration is from one to five days. It is due generally to ulceration in the mucous membrane of the duodenum or stomach, or to congestion of these parts without ulceration. Many theories have been advanced to explain the pathogenesis of gastro-intestinal hæmorrhages, according to some of which they are produced by pressure on the body of the fœtus during labour; it has recently been suggested that they are due to lesions of the central nervous system (11). A streptococcic origin has also been ascribed. The treatment consists in the maintenance of the body-heat, and in the administration of two or three minims of liquor ferri perchloridi every two hours. There can be no doubt that in some cases melæna neonatorum, like omphalorrhagia, is simply a symptom of hæmophilia, or of infantile syphilis; the treatment appropriate to these conditions will then be indicated.

Icterus neonatorum, or jaundice of the new-born, may be divided into physiological or *idiopathic* icterus and *symptomatic* icterus. To these may be added the jaundice of Winckel's disease, which has already been described, and need not be again referred to. *Idiopathic jaundice* is characterised by the yellowish coloration of the skin which appears a few days after birth, persists for a few days, does not commonly spread to the sclerotic, and disappears without causing much, if any, systemic disturbance. It is comparatively common, hence the name *physiological* sometimes given to it. With regard to its etiology and pathogenesis the most diverse views have been advanced; it has been ascribed to retention of the meconium, to late ligature of the cord, to chloroform administered to the mother in labour, to congenital debility and prematurity; it has been looked upon as due to changes in the blood, such as the destruction of red corpuscles (hæmatogenous theory), or to alterations in the liver, such as epithelial blocking of the bile ducts, and persistence of the ductus venosus (hepatogenous theory). Manifestly there is room for many further observations on this subject, but probably it will be found to be associated with the readjustment changes in the structure of the blood, and in the action of the liver, which occur in neonatal life. Fortunately the jaundice rarely causes anxiety, and usually yields to a dose of castor oil. *Symptomatic* icterus, as the name indicates, is the manifestation of several pathological conditions which may affect the new-born; but in them all there is an obstacle to the passage of bile from the liver. The most serious cases are those in which there is a congenital obliteration of the bile ducts due to malformation or to fœtal peritonitis; in them the jaundice is soon very intense, the stools are colourless, the abdomen distended, and vomiting frequent. In other cases the jaundice is the result of septic infection of the umbilicus which leads to perilobular cirrhosis of the liver (possibly Buhl's disease may be of this nature); in other instances the hepatic lesion is caused by syphilis of the new-born, and then mercurial treatment may be successful in curing the icteric state. In some very rare observations jaundice of the new-born has been found to have been caused by biliary calculi, which must necessarily have existed in intra-uterine life.

Ophthalmia neonatorum, like several other maladies of the new-born, is the result of infection; in this case the infection is gonorrhœal, takes place during labour (intra-natal), and affects the conjunctival sacs instead of the umbilicus. It has the characters of a purulent conjunctivitis, and is generally caused by vaginal secretion containing the gonococcus entering the infant's eyes during the progress of the head through the maternal passages. It used to be very common in Maternity Hospitals, and its after effects were often most disastrous,—corneal ulceration, prolapse of the iris, staphyloma, etc. following and producing blindness. It may be prevented, and practically abolished, as was shown by Credé in 1880. Into the eyes of every infant born to a mother suffering from a vaginal discharge, it is well to drop one or two minims of a 2 per cent solution (10 grs. to 1 oz.) of nitrate of silver, or, as has been demonstrated lately, simply to wash the eyes carefully with boiled water, may be sufficient to prevent the infection. When, however, the conjunctivitis has commenced, it will be necessary to paint the lids with the nitrate of silver solution, and to anoint their edges with zinc ointment. If one eye only be affected the infant should be kept lying on the affected side in order to try to save the other eye from infection with the discharge.

Pemphigus neonatorum is usually syphilitic in nature (*vide* article on "Syphilis"); rarely simple or benign pemphigus is met with in the new-born. It is characterised by the appearance a few days after birth of bullæ, usually discrete, on the trunk of the infant: they contain at first clear fluid, which afterwards becomes turbid when the bullæ burst and dry up. In this form, as distinguished from syphilitic pemphigus, the soles and palms are commonly free from bullæ. The general health is not much affected, and the duration of the illness is about a week. It used to be common in Maternity Hospitals, and is infectious in its nature. The treatment is the protection of the affected skin from injury and cold, and the internal administration of quinine.

Sclerema neonatorum is a rare disease of the new-born, characterised by induration of the subcutaneous tissue, little amenable to treatment. It has by some been ascribed to solidification of the panniculus adiposus by cold in infants in a state of collapse; but it is more probably due to the permeation of the subcutaneous adipose tissue layer, with numerous bands of connective tissue forming a network. Possibly the primary pathogenetic factor is a lesion of the trophic nervous centres. The child is usually atrophic, and the skin, first of the limbs and later of the whole body has a hard and cold feeling; there is even some rigidity of the parts; the temperature falls very rapidly; and the infant dies with or without such complications as pneumonia, diarrhœa, and hæmorrhages. *Œdema neonatorum* is possibly in some cases a stage in the development of sclerema; in others it is the symptom of several maladies, such as nephritis, cardiac, and pulmonary disease in the new-born. Both sclerema and œdema neonatorum are very intractable. The subject should be put in the incubator, the skin may be massaged, and hydrargyrum cum creta may be given internally.

The morbid conditions of the new-born which remain to be described have most of them been ascribed to the traumatism of labour, although into some of them the element of infection has been shown to enter.

Cephalhæmatoma neonatorum.—Occasionally (once in five hundred cases of labour) a swelling forms on the head of the new-born infant, which is obviously more than the caput succedaneum of parturition. The caput of labour is simply an effusion of serum, or of serum and blood into the tissues of the scalp over that part of the head which has presented; the true cephalhæmatoma, or as it is sometimes called, the sub-pericranial variety, consists in the pouring out of blood between the pericranium and the underlying bone, especially in the neighbourhood of the postero-superior angle of the parietal bone (right or left). It has been ascribed to rupture of small blood-vessels crossing the fissures in the margins of the parietal and occipital bones, which are often seen along the line of the lambdoidal suture near the posterior fontanelle. The swelling, which varies in size from a small nut to an orange, is firm and tense, has a fluctuating centre, and a hard rim or margin due to a deposit of new bone round the circumference, and it usually appears soon after birth, and absorbs slowly, occupying as long as two or three months in some cases. It seldom suppurates, and it has been considered best to leave it alone, simply protecting it from injury, and applying evaporating lotions; possibly aseptic surgery may yet find it better to open it at once and evacute the blood, but this more radical method of treatment has not become customary.

Facial paralysis, when it occurs in the new-born, is usually unilateral, and is caused by the pressure of one of the blades of the forceps upon the seventh nerve at its point of exit from the stylo-mastoid foramen, more rarely by pressure of the maternal bony passages upon the same structure. It is therefore generally met with in infants whose birth has been instrumental or laborious. It can be recognised when the infant is crying or suckling; the wrinkles on the affected side are obliterated, and those on the sound side in comparison seem exaggerated; the mouth also is drawn to the sound side. The eye on the affected side cannot be closed (lagophthalmia). The paralysis is usually recovered from, although several weeks may elapse; but there is a central form of the affection, when the eye can usually be closed, in which the prognosis is not so good. Massage and electricity may be used.

Hæmatoma of the sterno-mastoid muscle is a swelling in the muscle caused by an effusion of blood into its substance followed by myositis, and possibly accompanied by infection (Kader, 12). The condition is often discovered quite accidentally, and is usually unilateral; but it has an importance, for it may be the origin of one of the forms of congenital torticollis. Massage and inunctions of unguentum potassii iodidi may be employed to aid absorption.

Mastitis neonatorum is an inflammatory swelling of the mammary gland in the new-born, due to injudicious handling by the mother or nurse, associated with microbic infection of the gland tissue. It will cease to occur when it is generally recognised that there is no need to squeeze out from the breasts the milky fluid which is found in them in the neonatal period of life. The mastitis may be checked at the beginning by firm bandaging of the breast; when, however, pus has formed it must of course be evacuated as soon as possible. The new-born infant may be born with other forms of injury than those mentioned above; it may show contusions and wounds due to instrumental interference, and it may be the subject of various fractures and dislocations produced during version, etc. Most of these are quickly recovered from if they are recognised at once and appropriately treated. Spoon-shaped depressions of the cranial bones may require to be elevated by pneumatic suction or the trephine, or simply by antero-posterior compression of the head (14).

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Night Terrors (PAVOR NOCTURNUS).—Upon few, if any, subjects in medicine have such widely divergent opinions been expressed by accepted authorities as upon that of night terrors. And this diversity of opinion attaches not only to the etiology of the complaint and the other disorders with which it is associated, but also to the importance with which it is to be viewed in regard to the present and future states of the sufferers from it. As a proof of this the following opinions may be quoted:—

Eustace Smith ascribes night terrors to digestive troubles, but lately has laid stress upon adenoids and other naso-pharyngeal disorders as factors in their causation. Warrington Haward attributes them to enlarged tonsils. Ringer considers them as arising from indigestion. Charles West agrees with this, although he says he has known serious brain trouble arising from them. Goodhart thinks them allied to somnambulism and nocturnal incontinence of urine. Moizard, Bouchet, Hesse, Soltmann, Silbermann, H. C. Wood, and others, link them with epilepsy. Angel Money, too, calls them a form of cortical epilepsy. Donkin mentions them amongst the emotional and other nerve disturbances which are common in rheumatic children. He states that night terrors, especially when frequent and accompanied by hallucinations, are often co-existent with and indicative of epilepsy; and further says, in his chapter on "Hysteria," that night terrors, with or without definite hallucinations described by the patient, are very common in hysterical children, but that they also occur occasionally in almost any child as the result of undue excitement and various kinds of nervous disturbance. In contrast to Donkin, Henoch says he has seldom seen them in connection with either hysteria or epilepsy. Graham Little has found them most frequently in rheumatic children suffering from morbus cordis.

The examples given sufficiently testify to the strange diversity of opinion on the question of night terrors. They also make it manifest that it is beyond the bounds of possibility that these writers could all have had the same disorder under consideration at the times at which they wrote. The present writer has endeavoured to show that there are two widely differing disorders in which the expression of terror has been associated with disturbance of sleep, and that it has been a non-discrimination between these two disorders that has led to this inconsistency amongst the various authors on the subject. Of these two disorders, the one is comparatively rare, and due to central brain disturbance; the other is extremely common, reflex in nature, and arises from digestive troubles or partial asphyxia. It will be well to restrict the name of "night terrors" to the first disorder, which is of importance, as that name has been deemed worthy of a permanent place in medical nomenclature; in the second, which is of only trivial consequence, an appropriate title is that of "nightmare," since it has already been widely adopted by the laity for the complaint. There are several points of distinction between the two disorders, a cardinal one being that in night terrors the patient sees visions, in nightmare he merely dreams dreams. The other points of distinction can be briefly summarised as follows:—

Night Terrors.—In this there is usually a neurotic family history, and not very infrequently the patient himself has been the subject of convulsions or other nervous disorder. Boys are slightly more liable to the complaint than girls. The attacks are most common between the ages of two years and eight, and they seldom persist after the twelfth year. The attack commences suddenly, in the midst of apparently the soundest sleep, and the first indication is usually a piercing shriek. On being attended to, the child is found seemingly wide awake, and protesting against the presence of some imaginary person or thing which he imagines is in the room with him. The nature of the vision is usually a terrifying one, such as a negro or a black statue, but in many cases, as in the aura of epilepsy, red plays a prominent part, and soldiers, blood, and fire are the objects complained of. Whatever be the nature of the vision, it is usually repeated in the same features in each attack, no matter how long the intervals between them. There is very seldom more than one attack in a night. In extremely exceptional instances the vision is a pleasing one, or the hallucination may be one of hearing and not of sight. During the whole of the attack the patient is hardly, if at all, conscious of his surroundings, and before even vigorous attempts to render him so succeed, he sinks into a profound sleep. In the morning he has generally no recollection of anything unusual having happened during the night. Care will have to be exercised on this point, as young children are apt to appropriate as their personal experience and knowledge any matters concerning themselves which may be mentioned in their hearing.

Nightmare.—In this there is usually nothing special in the family history. A large percentage of the patients are the subjects of adenoids or enlarged tonsils. In other cases it will be found that the bedroom is imperfectly ventilated, or that the patient suffers from digestive troubles, or has eaten an inappropriate meal on the evening of the attack. Although most common in childhood, the complaint is by no means limited to that age, and many adults know by experience the evil results of indiscretion in diet shortly before sleeping. Sleep is disturbed almost from the outset, and the attack is merely the culmination of a state of only partial rest disturbed by "bad dreams." As in night terrors, the patient usually awakes with a scream. He is found in a state of vague terror, and if he complain of definite objects, they had come upon him in his sleep, and are not visible to him at the present. Although perhaps greatly terrified, he is fully conscious of his surroundings and can be soothed into quietness, but it may be long before he is wooed to sleep, owing to his dread of something happening to him in that state. The objects of terror, if defined at all, are very commonly objects or persons that have frightened him in his waking moments. These objects may vary in each attack, and this may be the case when more than one attack occurs in a night. In the morning, if old enough, he has a very perfect recollection of the occurrences of the night before.

Closely allied to night terrors is a rare complaint in which a child, apparently in the deepest sleep, suddenly sits up in bed and begins to talk. The words are generally coherent enough, and may be addressed to some one present, or even to a doll placed in its arms. Careful observation, however, proves that the child is only partially, if at all, conscious of its surroundings. The stream of eloquence is generally rapid and incessant, and is only broken by the child abruptly returning into a deep sleep. In the morning the child has no recollection of the occurrences of the previous night.

Allied also to night terrors, but perhaps more closely to epilepsy, is the condition known as "daymare," in which the patient, not necessarily a child, sees visions in the day-time when seemingly awake. For an interesting account of some cases of this last reference may be made to a paper by D. G. F. Still.

Diagnosis.—This mainly rests in distinguishing between attacks of night terrors and those of nightmare, the chief indications for this having been already given. In an able article on night terrors Dr. Leonard Guthrie takes exception to these points of distinction, on the ground that they are too subtle for practical purposes. It may be claimed, however, that they are no more vague or indecisive than those used in deciding between such complaints as epilepsy and hysteria. It is not to be expected that all the points of distinction between the two complaints should be present in every case, and even after the utmost care has been exercised, there still remain a minority of cases in which uncertainty must exist as to which class they should be placed in, that of night terrors or that of nightmare.

Prognosis.—There is no element of danger in the attacks themselves. Their strong resemblance, however, to some of the phases of epilepsy should engender caution in pronouncing as to the future of the subjects of night terrors. In rare instances the two complaints are associated in the same subject. More commonly there is an interval, of greater or less duration, between the supervention of the one complaint upon the other. But epilepsy is far from the only, and perhaps not even the most frequent, sequel of night terrors. Other nervous disorders, such as migrane, chorea, hysteria, asthma, somnambulism, somniloquence, etc., play as important a part in this direction as epilepsy. Occasionally, too, night terrors is followed by some form of insanity. In fact, probably, few of the subjects of night terrors pass through life without incurring some other form of nervous disturbance; although, fortunately, the manifestations of this last may be so slight or trivial as only to be revealed by the most careful and searching inquiry and examination. Having regard to this, night terrors, although of no great importance in themselves, should be regarded as danger-signals, and as constituting a warning to the possible advent of other neuroses in the near or distant future.

Treatment.—If the attacks be frequent, a dose of potassium bromide, suitable for the age, can be given shortly before bedtime. Except in the case of frequency, however, a course of bromide is certainly undesirable. Any conditions that experience may prove to act as exciting causes for the attacks should be studiously avoided. The only effective treatment is the endeavour to prevent, in the training and education of the patient, any undue stress being thrown upon the nervous system. For this purpose a total avoidance of all excitement, and a careful watch over the effects of study, are all essential. Lapse of time by itself will generally bring about a cessation of the night attacks, and there is reasonable hope that proper care in the training of the child may prevent the onset of sequelæ of any importance.

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Nipple. *See* MAMMARY GLAND and PUERPERIUM.

Nodding Spasm. *See* SPASM.

Noma. *See* STOMATITIS.

Nose.—The diseases of the nose are considered in the following sections:—

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1. Examination of the Nose

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1. General Examination

(*a*) *Exterior of the Nose and Aspect of the Face.*—Careful note should always be taken of the appearance presented by the external nose. Bendings of the dorsum may indicate deflections of the septum, although the latter often occur without external evidence. The bones and cartilages may be bulged outwards by polypi or other intra-nasal growths, which in some cases appear through the nostrils. When the nasal cavities are completely impervious, or in a less degree when they have been much obstructed for a length of time, the tip of the nose assumes a pinched aspect. Its alæ are pressed towards the septum and wasted, the mouth being constantly more or less open, the folds between the nose and upper lip are obliterated, whilst owing to the connection which subsists between the orbicularis and other muscles of the face (W. Meyer), the inner canthi of the eyes are drawn down, the eyebrows pushed upwards, and the skin of the forehead corrugated. The face altogether acquires a dull, listless expression.

The broad flattened bridge in cases of ozæna, and the great depression of the nasal bones occurring in tertiary syphilis, must be mentioned, as likewise the thickening sometimes met with in tuberculous nasal disease and in rhinoscleroma.

Redness of the alæ and tip of the external nose, unless due to some other obvious cause, should lead us to suspect intra-nasal irritation. Excoriations at the edges of the nostrils are common when there is much secretion from the nasal cavities.

Note should always be taken of any inequality of the two sides of the face, such as occurs in congenital occlusion of one posterior naris, and of any special prominence of one superior maxilla resulting from disease in the antrum.

Enlargement of the transverse vein at the root of the nose has been described as a symptom of obstruction of the posterior part of the nose. (Scanes Spicer).

(*b*) *Character of the Voice.*—Important information may be gathered from observing the character of the voice. Complete closure of the anterior nares affects the voice, as heard by another person, as follows: non-nasal vowels (*i.e.* vowels properly pronounced so that no air enters the nose) are not appreciably affected; the non-nasal consonants (such as *b*, *d*, *c*, *s*, etc.) are not altered. The nasal vowels (*i.e.* vowels pronounced with an escape of air into the nose) become more distant, their resonance is altered in character. The nasal consonants (*m* and *n*) are heard more distantly and with an altered nasal resonance. Obstruction in the naso-pharynx destroys all nasal resonance, rendering the voice "dead," turning the consonants *m* and *n* into *b* and *d* respectively. When growths obstruct the posterior nares, but do not project into the naso-pharynx, a certain resonance of the voice remains as pointed out by W. Meyer.

(*c*) *Patency of the Nasal Passages.*—The methods at present generally in use for ascertaining the patency of the nasal passages are certainly deficient in accuracy, but with experience they give practically a good idea of the amount, if any, of obstruction present. They are as follows:—

1. Place the patient opposite to you facing the window, and let him breathe with his mouth closed, first quietly, then forcibly; note whether there is any retraction of the alæ on inspiration, and any difficulty in keeping the mouth closed.

2. Close the nostrils alternately by placing your thumb in an upward direction against one anterior naris, making the patient breathe in and

out. The sound produced is a guide to the amount of obstruction, the broad soft sound of a wide canal contrasting markedly with the shrill note of a much obstructed passage.

Several instruments for a more scientific examination of the perviousness of the nose have been devised, but as they have not yet come into practical use a description of them here is out of place.

(*d*) *Character of the Patient's Breath.*—During the above examination it is well to notice whether the patient's breath has any special odour, and if so, whether the latter emanates from the nose or from the mouth. If the former, whether the smell is confined to one or the other side, and a very little experience will enable one to distinguish between the smell due to ozæna, to necrosed bone (as met with in syphilis), and the less pungent odour attached to abscess in the accessory sinuses.

(*e*) *Senses of Smell and Taste.*—The patient, if intelligent, may usually be trusted to give a sufficiently accurate account of his sense of smell and taste, provided that the distinction between true taste (by means of the glossopharyngeal and lingual nerves) and the taste of flavours (by means of the olfactory nerve) be explained to him. If not, his sense of smell is tested *qualitatively* by exposing certain scents below first one and then the other nostril. The taste of flavours may be tested by swallowing with both nostrils open, or with one closed. Zwaardemaker's olfactometer may be used for the *quantitative* estimation of smell. It consists of a graduated glass tube, one end of which is inserted into one nostril, whilst over the other end fits a sliding tube which is either made of an odoriferous substance (such as gutta percha), or impregnated with an odoriferous liquid. The length of the outer tube, which needs to be exposed beyond the glass tube in order that the smell may be perceived, gives a rough estimate of the amount of smell power present.

(*f*) *Character of the Secretion from the Nose.*—Discharge from the nose may be of any consistence, varying from a clear white serous liquid to a thick, creamy, purulent secretion; it may be more or less tinged with fresh or old blood, and present the form of hard crusts of inspissated pus. Various living creatures may occasionally be found in the secretion, such as ascarides, centipedes, earwigs, and the ova and larvæ of several varieties of flies. The quantity of the discharge varies very greatly. It may escape through the anterior or posterior nares, in the latter case passing into the pharynx. It may be one or both sided.

Microscopical and *bacteriological* examination are necessary in order to make a complete examination of the secretion. Microscopically, the secretion from the nose may be found to contain blood, pus, mucus, epithelial scales, fungi (*e.g.* aspergillus fumigatus, and oidium albicans).

Numerous observations have shown that, in the normal state, the vestibules swarm with bacteria. The nasal cavities always contain a greater or less quantity of microbes, but they are not nearly so numerous as might be expected (Hajek, Park, Wright, and Viollet). St. Clair Thomson and Hewlett arrived at a different conclusion, as they only found microbes present in 20 per cent of their observations, and, according to Piaget, they are absent in the deeper parts of the nasal cavities. Klemperer, on the other hand, never found a nose free from germs, not even in its uppermost parts.

The chief organisms that have hitherto been detected in the nasal cavities are, according to Viollet, as follows:[1]—Friedländer's pneumo-bacillus, Fränkel's pneumococcus, staphylococcus pyogenes aureus et lutes, micrococcus liquefaciens albus et flavus, streptococcus pyogenes, micrococcus cereus flavus, micrococcus tetragonus, bacillus tuberculosis, sarcina alba, lutea et aurantiaca, bacterium coli, bacillus pseudo-diphtheriæ, meningococcus intracellularis of Weichselbaum.

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[1] *L'infection respiratoire: Moyens de défense de l'organisme.* Paris, 1900, pp. 44 and 45. This work contains a very complete history of the literature of the subject.

The question whether the sparsity of germs is due to the action of the ciliated epithelium, to the bactericidal properties of the nasal mucus, or to phagocytosis, is one which is much debated, but belongs to the domain of the physiology of the nose.

As a rule special varieties of bacteria cannot be considered responsible for special diseases (Hajek and Rohrer). The chief exceptions are: (1) Tuberculous affections of the nose—bacillus tuberculosis; (2) Glanders—bacillus mallei; (3) Rhinitis diphtherica—Löffler's bacillus diphtheriæ; (4) Leprosy—bacillus lepræ; (5) Rhino-scleroma—Frisch's bacterium.

In the following diseases two or more varieties of bacteria have been found:—

1. Simple perforating ulcer of the septum (ulcus perforans)—streptococcus pyogenes and staphylococcus pyogenes aureus.
2. Rhinitis blenorrhoica—streptococcus pyogenes, micrococcus erysipelatosus, and gonococcus.
3. Rhinitis pseudo-membranacca—Klebs-Löffler bacillus, bacillus pseudo-diphtheriæ, staphylococcus, pneumococcus.
4. Influenza-rhinitis—Pfeiffer's bacillus, pneumococcus, streptococcus, and staphylococcus aureus.

In other inflammatory diseases of the nose, such as acute and chronic rhinitis, acute and chronic inflammation of the accessory cavities, many varieties of cocci and bacilli have been found, but their relationship to these diseases has not been definitely established. According to Abel the bacillus mucosus is always present in and may be regarded as the cause of ozæna.

Chemical examination of the secretion from the nose may be necessary in order to distinguish it from cerebro-spinal fluid, which may escape through that organ. The presence of reducing substances, as shown by Fehling's test, and the absence of mucin distinguish cerebro-spinal fluid (St. Clair Thomson).

2. EXAMINATION OF THE INTERIOR OF THE NOSE AND NASO-PHARYNX

(*a*) *Anterior Rhinoscopy.*—Anterior rhinoscopy, or inspection of the nasal chambers from the front, requires: (1) a speculum to dilate the vestibule, or at least retract the ala; and (2) a strong light, which should be thrown into the nose by a reflector attached to the observer's forehead. The number of different specula which have been devised is very large; those most commonly used are known as Duplay's, Thudichum's, Fränkel's (with fenestrated or solid blades), and Hartmann's (which has long handles, and is a modification of Kramer's ear speculum). The form I usually employ for examinations is Duplay's, as the pressure can be so accurately regulated by means of the screw, and for operations I use Hartmann's, modified by making the blades broader and more like Duplay's. When both hands are required, which is rare, the speculum must be held by an assistant, or a self-retaining speculum, be used. The illumination employed may be either sunlight or artificial light; for the latter, electric light is most convenient (a 32 candle-power lamp, fitted with a bull's-eye condenser), in its absence an argand gas-burner with a bull's eye answers well. Limelight, though giving splendid illumination, is too complicated to be generally employed. When sunlight is used the reflector should be plane; when artificial light is employed a concave reflector, having a focus of about ten inches, is required. The reflector may be fixed either to a spectacle-frame or to a band passing round the forehead. The light is best placed on the right side of the patient, rather behind and above his head. In this way the right hand, when used for introducing a probe or other instrument, does not intercept the light. Direct illumination is unsuitable for anterior rhinoscopy.

Method of Performance.—The patient being seated opposite the surgeon on the same level, the light is thrown with the reflector on to the nostril, and before the speculum is introduced the tip of the nose should be raised with the thumb and the columella, and both vestibules examined to see if there is any irregularity of the cartilaginous septum. The speculum being inserted into the vestibule with the left hand, and the blades gently separated as far as possible without hurting the patient, the beam of light is directed into it. Three positions are usually necessary for a full examination, the patient's head being guided into them by the right hand placed either on the vertex or on the patient's occiput, in the latter case the thumb being on the patient's left cheek. It is best to commence with the patient's head slightly thrown back; in this position the lower part of the middle and the anterior end of the inferior turbinated body are seen. By tilting the head farther back the neck of the middle turbinated body and the roof of the nasal fossa come into view, and by bending the patient's head sharply forwards the inferior meatus, the palatal muscles, and the floor of the nose become visible. By repeating these positions with the patient's head slightly turned to the opposite side, the corresponding portions of the septum can be inspected.

Anterior Rhinoscopic View.—The view obtained by anterior rhinoscopy depends largely on the amount of erection of the inferior turbinated body; if that body is much erected, no view of the deeper parts of the nasal cavity can be obtained. The inferior turbinated body itself appears as a round, shining eminence with a smooth surface, which is either in contact with, or in close proximity to, the septum. Above it is prolonged into a broad neck, which, if the erection be extreme, completely conceals the middle turbinated body. The sensation produced by touching the inferior turbinated body with a probe is that of a soft cushion which can be deeply indented by pressure, but rapidly regains its original shape. To make an examination under these circumstances it is necessary to contract the erectile body by applying cucaine to the mucous membrane. This can be done either by spraying a 5 per cent solution of the hydrochlorate with a small hand spray through the anterior naris, or by inserting a small pellet of absorbent wool saturated with the same solution into the nasal cavity. The entrance of cocaine into the throat is more easily avoided by using the latter method.[1] After an interval of a quarter of an hour collapse of the erected turbinated body is at its height, and the parts appear as shown in Fig. 1.[2] *Inferior Turbinated Body.*—The anterior extremity, or the presenting part, forms a somewhat irregular undulating surface, terminating below in a more or less sharp margin which overhangs the inferior meatus. Above, it tapers gradually into the outer wall of the nasal cavity, forming, as viewed from the front, a kind of "neck" (Fig. 1, *l*); the inner surface of the body (*i.e.* the septal surface) can be traced far back, often to its posterior extremity. The greatly fore-shortened view of this surface may present the appearance of a shallow concavity or of a slightly rounded eminence. It is best seen by turning the patient's face towards the side under examination. On account of the comparatively small size of the bone itself this position is sometimes necessary, even to see the inferior turbinated body. *Middle Turbinated Body.*—Above, and at a considerably greater distance from the orifice, is seen the middle turbinated body. The parts visible, providing there is nothing to intercept the view, are the anterior and inferior borders (*c* and *f*) and part of the internal surface. The angle of junction of the two borders is the part nearest to the observer's eye. Each of these borders presents an inner and an outer lip. Theoretically these are the parts which should be seen, but practically a considerable portion of the middle turbinated body is often hidden by the tubercle of the septum (*d*). If the tubercle be not very large, the inner lip of the anterior margin of the middle turbinated bone is to a great extent hidden from view, but above the tubercle is seen the neck of the bone (*e*), *i.e.* the narrow portion where it joins the body of the ethmoid bone. On its inner side a portion of the olfactory slit (*g*) is visible; on its outer side is a depression (*k*) which forms part of the middle meatus. The tubercle often conceals the neck and whole of the inner lip of the anterior border of the middle turbinated body, leaving only the outer lip of the anterior border, the angle, and the lower border exposed to view. The tubercle must not be mistaken for a deflected septum. The mucous membrane covering the middle turbinated body is normally smooth and shining in appearance, and often presents a very minute red and yellow mottling. *Septum.*—The septum at its lower part may be traced as a slightly undulating surface passing directly backwards to the posterior naris. General or partial bleedings of the septum are common. Slight irregularities are so often met with that they can scarcely be considered abnormal. A small conical elevation opposite the anterior end of the inferior turbinated body is of frequent occurrence, and often has a ridge running upwards and backwards from it. Above, the septum presents the tubercle as already mentioned; below, it joins the floor of the nasal cavity, which appears as a somewhat hollow surface seen greatly fore-shortened. By projecting the light through the inferior meatus (*j*), the posterior wall of the naso-pharynx and the movements of the palatal muscles during deglutition and phonation are often visible. These when clearly made out form a good test to the permeability of the inferior meatus. In exceptionally wide nasal cavities the upper margin of the posterior naris, bounded by two arches, one immediately above the other, may be seen, and above these again the anterior surface of the body of the sphenoid bone. *The middle meatus* is situated between the middle and inferior turbinated body, and on the space existing between the middle turbinated body and the outer wall of the nasal cavity depends the depth to which this meatus can be inspected. As regards colour the inferior turbinated body is the darkest, being of a deeper colour than the mucous membrane of the mouth. The septum is the next darkest portion, and the middle turbinated body lighter than either.

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[1] Cocaine has not only an ischæmic, but also an anæsthetic effect on the nasal mucous membrane, it cannot, therefore, be employed when it is desired to test reflex nasal irritability with a probe. Eucaine, which also acts as a local anæsthetic, has very slight ischæmic properties. When ischæmia is desired, it may be combined with extract of suprarenal capsule, but for examining the nose, cucaine, unless specially contra-indicated, stands first.

[2] *A Guide to the Examination of the Nose*, by E. Cresswell Baber. London, 1886.

Use of the Nasal Probe.—The use of the nasal probe under guidance of the eye is of great importance for controlling the appearances seen in any part of the nasal cavity, and for ascertaining the reflex irritability of the different intra-nasal structures. It should be blunt, but not bulbous, non-flexible, and attached at an obtuse angle to a suitable handle.

(*b*) *Posterior Rhinoscopy.*—Posterior rhinoscopy, or inspection of the nasal cavities and naso-pharynx from behind, is accomplished by placing a small mirror at a suitable angle in the pharynx, and concentrating on it a strong light in the optical axis of the observer. Light is thus thrown into the naso-pharynx, and the image of the illuminated parts is seen by the surgeon. The appliances required are:—1. A powerful light; 2. A small rhinoscopic mirror; 3. A tongue depressor. The light may be the same as

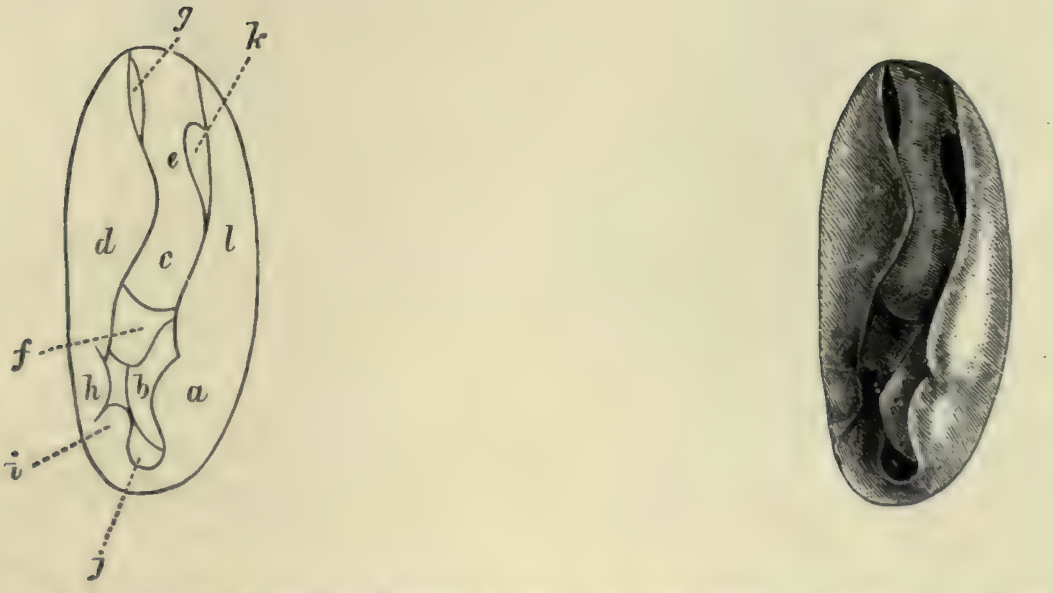

FIG. 1.—Left anterior rhinoscopic view in a woman, aged 26. *a*, Anterior extremity (collapsed) of inferior turbinated body; *b*, inner surface of same, seen in perspective, showing a rounded swelling; *c*, anterior border of middle turbinated body, ending below in the angle, which in this case presents a puffy swelling; above, the anterior border terminates in the neck of the body (*e*); *d*, tubercle of the septum; *f*, lower border of middle turbinated body; *gk*, depressions on either side of the neck; *g*, forming part of the olfactory slit, and *k*, a portion of the middle meatus; *h*, a moderately deep-seated swelling on the septum; *i*, ditto, much further inwards; *j*, inferior meatus, through which the movements of the palatal muscles can be seen; *l*, "neck" of the inferior turbinated body.

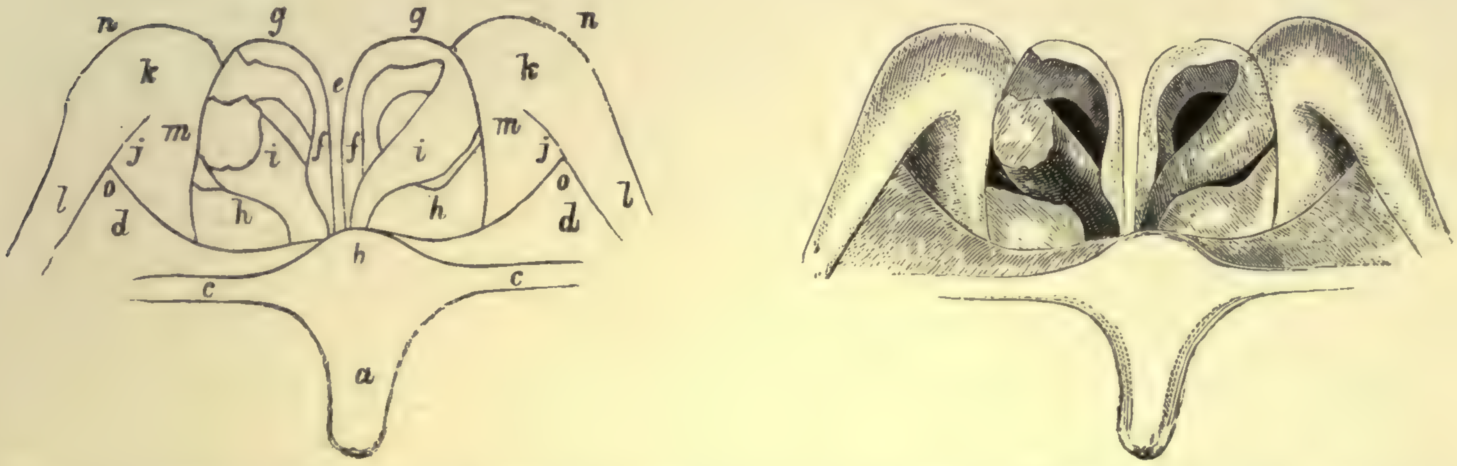

FIG. 2.—Posterior rhinoscopic view, seen with the mirror in the ordinary position and without the use of any instrument to draw forward the palate. *a*, Posterior surface of uvula; *b*, uvula cushion; *c,c*, posterior margin of palate (arcus palato-pharyngei); *d,d*, levator cushions; *e*, septum nasi; *f,f*, swellings on the sides of the septum; *g,g*, choanæ or posterior nares; *h,h*, inferior turbinated bodies; *i,i*, middle turbinated bodies; *j,j*, Eustachian openings, more strictly the depressions leading to them; *k,k*, Eustachian cushions; *l,l*, salpingo-pharyngeal folds; *m,m*, salpingo-palatine folds; *n,n*, position of upper part of Rosenmüller's fossæ; *o,o*, posterior tubal sulci.

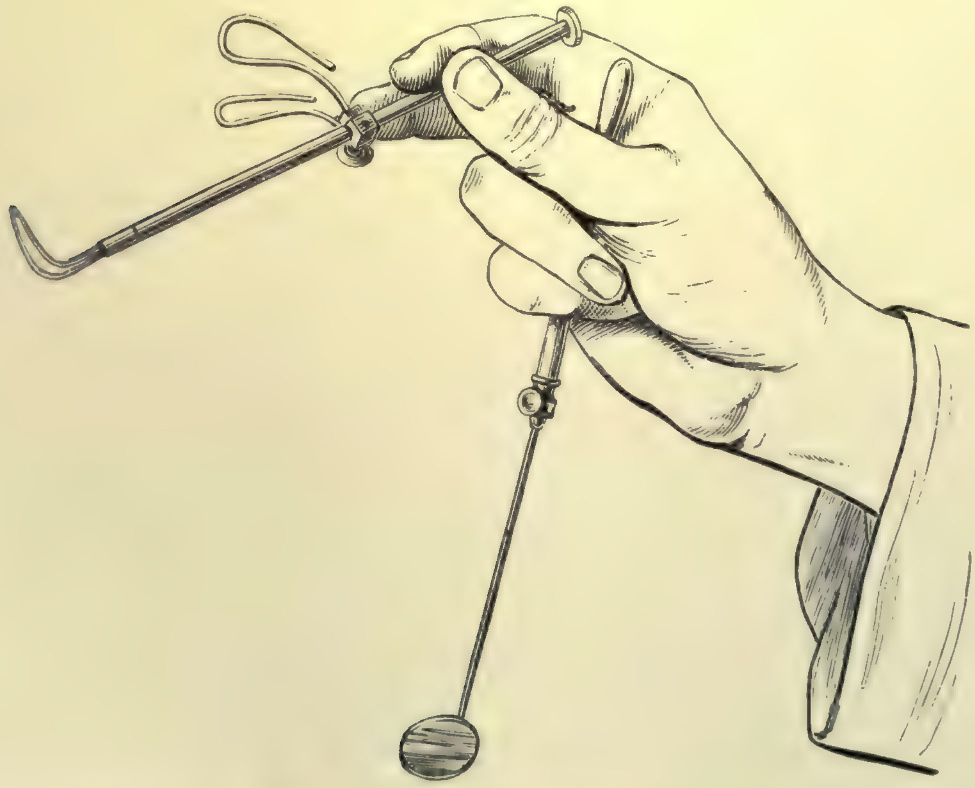

FIG. 3.—Method of holding the self-retaining palate hook and mirror previous to an examination of the naso-pharynx.

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that used in anterior rhinoscopy, and the same means can be employed for concentrating and reflecting it. The rhinoscopic mirror should be circular and varying from half an inch upwards in diameter. If fixed it should be attached to the shaft at an angle of 110°, but a larger angle is convenient for viewing the roof and posterior wall of the naso-pharynx. Preferable to the fixed mirror is Fränkel's, in which, by an ingenious arrangement, the angle of the mirror to the shaft can be altered after the instrument is in position. A tongue depressor is usually required for posterior rhinoscopy; it should be angular, and not broader than necessary to keep down the centre of the tongue.

Method of Performance.—The patient is seated with his head vertical or bent slightly forwards, and the observer takes up his position facing him on a rather lower seat. The patient being then told to merely open his mouth and not inhale or hold his breath, the tongue is gently, but firmly, held down with a tongue depressor, and the light from the reflector thrown on to the posterior wall of the pharynx. The previously warmed rhinoscopic mirror, with the reflecting surface directed upwards, is then rapidly passed into the pharynx, just below the velum, until it nearly, but not quite touches the posterior wall of that cavity. Then by gently depressing the handle (thus raising the mirror and rendering it more nearly vertical), if there be sufficient space between the velum and the posterior pharyngeal wall, the posterior rhinoscopic image comes into view. The parts first seen are probably the posterior surface of the uvula and velum. Above this a whitish vertical band is visible, the posterior margin of the septum of the nose. The other parts of the posterior rhinoscopic view are then seen by slight movements of the mirror in different directions.

Posterior Rhinoscopic View (Fig. 2).[1]—It should be borne in mind that as we are looking at the naso-pharyngeal cavity from below, both the anterior, lateral, and posterior walls will appear considerably foreshortened in a vertical direction, also that the portion of the lateral wall of the cavity which is in front of the mirror (and which therefore requires the mirror to make with it an angle larger than 45°) is subjected to a horizontal foreshortening. The former is minimised by holding the mirror as high as possible, the latter by placing the mirror in the position recommended by Zaufal for seeing the salpingo-pharyngeal fold, viz. low down in the pharynx with its back against the tonsil or posterior faucal pillar of the opposite side.

Uvula and Soft Palate.—Above the posterior surface of the uvula (*a*) is seen a rounded fleshy eminence (*b*), the uvula cushion, and on either side, receding into the distance, the levator cushion (*d*). The *septum* (*e*) appears as a pale median ridge broadening above. On the two sides are commonly seen prominences of the mucous membrane (*f*, *f*). *The choanæ or posterior nares* (*g*, *g*) are visible as two oval-shaped openings, one on either side of the septum. The lowermost part of the oval is usually concealed by the soft palate. Owing to the foreshortening they appear shorter than they really are. In each are commonly seen the three turbinated bodies and the two upper meatuses. The *inferior turbinated body* (*h*) appears as a rounded swelling at the bottom of each choana, a large portion of it being hidden by the velum palati. It is generally gray, and corrugated on the surface. *The middle turbinated body* (*i*) has a light red colour and a smoother surface. Its septal surface can often be traced running forwards into the nasal cavity. The *superior turbinated body* may appear as a narrow ledge running parallel to the middle, but it is not always clearly visible. The posterior end of the inferior turbinated body may become temporarily swollen by the distension of its erectile tissue. Of the *three meatuses* the inferior cannot be seen, owing to the position of the mirror. *Eustachian Orifice.*—Immediately to the outer side of each choana, and *apparently* on a level with the middle meatus, is seen the orifice of the Eustachian tube (*j*), or rather the depression leading to it. It appears as a light triangular depression with a dark outline, the base of the triangle being directed inwards towards the margin of the choana. Above it is the Eustachian cushion (*k*), which appears as a thick red lip. Behind it curves downwards as the salpingo-pharyngeal fold (*l*), and in front it passes into the less well-marked salpingo-palatine fold (*m*). Though in reality on a lower level, the upper margin of the Eustachian cushion appears in the mirror higher than that of the choana. Immediately above the upper margin of the Eustachian cushion is seen the roof of the naso-pharynx, and tracing this backwards it passes gradually into the posterior wall, a depression being often visible in the median line at the junction of the two, the opening of the so-called pharyngeal bursa. To the outer side of the cushion (as regards its rhinoscopic view) is seen the fossa of Rosenmüller, which is often traversed by bands at the point (*n*).

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[1] *Ibidem*, p. 109.

Examination with the Probe.—The consistence, form, and mobility of these parts may, under favourable circumstances, be ascertained by the use of a post-nasal probe, under guidance of the eye, or a probe may be introduced through the nose, its movements being watched in the rhinoscopic mirror. For the former purpose the probe should be a long one, and bent at right angles at a distance of about 1½ inch from its distal end. It is best made of silver, so that the curve may be altered if desired.

Difficulties in performing Posterior Rhinoscopy.—These are chiefly twofold—(1) Irritability of the tongue and pharynx, which can generally be overcome by spraying in or plugging the parts with a 5 or 10 per cent solution of hydrochlorate of cocaine; (2) Obstruction produced by the soft palate. Contraction of the muscles may cause the soft palate to rise, preventing all view of the naso-pharynx. This may often be overcome by explaining to the patient that he is not required to do anything but open his mouth and breathe in the ordinary way. If this fails, one of the following devices may be tried, viz.:—(1) Direct the patient to sniff up gently through the nose; (2) Make him pronounce a nasal sound, such as the French word "on" or the English "hang"; (3) Cause him to make a snoring noise; (4) Instruct him to take a succession of short, sharp, gasping inspirations. When it is impossible to cause relaxation of the palate by these means, or in cases in which there is not sufficient space between the velum and the posterior pharyngeal wall even when the palate is relaxed, that organ should be drawn forwards with a White's palate hook.[1] This instrument is made of a square steel bar about 3 millimetres thick, terminating in a loop of pure silver wire, heavy enough to hold the palate and yet light enough to be changed in shape by the fingers if required. On the bar slides the attachment which clamps over the upper lip and holds the retractor in position. This sliding attachment with two arms requires no fixation to keep it in position, the tension being alone sufficient to make it immovable. For greater security, however, in performing an operation, a small fixation screw is added. The mode of application is as follows:—The hook is held between the thumb and first two fingers in the manner shown in Fig. 3, and a rhinoscopic mirror, previously warmed, is grasped between the last two fingers and the palm. The tongue being held down by an angular depressor in the left hand, the hook is introduced well behind the velum, and the patient being told to close his lips around the hook, without biting it, and inspire through the nose, the clamp is pushed rapidly forward with the second finger of the right hand until the loops are pressed firmly into the depressions on either side of the nose, where they remain. The already warmed mirror can then immediately be employed to view the naso-pharynx. The patient should be directed to breathe deeply during the examination. Removal of the hook is accomplished by catching and drawing backwards with the finger the under part of the sliding attachment. By adopting this plan the hook need only be kept in for a very short time for a simple examination. Cocaine is usually required, but may often be dispensed with for a simple inspection when the palate is weak and the patient not very sensitive. The cocaine is best applied by injecting into either nostril, with a small syringe, a few drops of a 10 per cent solution, and holding the patient's head well back so as to let it run over the velum. For examination of the naso-pharynx the hook is invaluable, as it renders narrowness of the post-palatal cleft no impediment. Other advantages are that a large-sized mirror (one having a diameter of $\frac{3}{4}$–$\frac{7}{8}$ of an inch) can usually be employed, the illumination of the parts is consequently brighter, and as there is a larger field of vision the different structures are more easily recognised. The view of the anterior and posterior walls of the cavity is also less foreshortened; indeed, for anatomical reasons, no inspection by rhinoscopy of the posterior wall can, as a rule, be considered complete unless some means are used for drawing forward the palate. A little practice on the part of the surgeon enables the hook to be employed in almost any adult case at the first sitting.

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[1] See articles by the author, "A Recent Improvement in Posterior Rhinoscopy" (*British Medical Journal*, 12th January 1889), and "Further Remarks on the Self-retaining Palate-hook" (*ibid.* 28th June 1890).

The posterior wall of the naso-pharynx may also be examined *directly*, often up as high as the pharyngeal bursa, by inserting the palate hook loosely, tilting its distal end well up, and throwing back the patient's head as far as possible. Other palate hooks have been devised, but this, as far as I have seen, is the most practical one. Some authors also recommend that the palate be drawn forward by rubber tubing inserted through the nasal cavities.

(*c*) *Palpation.*—Indirect palpation with a probe has already been mentioned; direct palpation with the finger may be anterior or posterior. Anterior palpation is done by inserting the little finger through the vestibule. The anterior part of the septum and inferior and middle turbinated bodies can be reached by this method. Posterior palpation, by inserting the finger into the naso-pharynx, is a proceeding more frequently employed.

Method of performing Posterior Palpation.—The patient being seated, the surgeon stands on one side, and with his arm going behind the patient's head, holds a simple gag (such as Meyer's) in position. He then passes the forefinger of the opposite hand (preferably the left on account of its smaller size) rapidly to the posterior wall of the pharynx, and up behind the soft palate, until the posterior edge of the nasal septum is felt as a thin hard ridge. On either side of the septum the posterior ends of the inferior turbinated bodies (sometimes those of the middle turbinated bodies also), especially if they are at all swollen, give the impression of soft cushions. They may be considered abnormal if they project into the naso-pharynx. The situation of the Eustachian cushion and orifice and the salpingo-pharyngeal fold can also be felt on either side, and behind these Rosenmüller's fossæ. The roof and posterior wall of the naso-pharynx should be carefully examined. Normally these parts have an uneven, irregular surface, but when adenoid vegetations are present they are studded with more or less pedunculated growths of all sizes and shapes. Palpation must be rapidly executed as it may produce retching. The first joint of the surgeon's forefinger may be conveniently protected from the patient's teeth by wrapping a piece of linen round it. Difficulty in getting a child to open its mouth can usually be overcome by moral suasion; if not, pressure of the cheek between the jaws with the surgeon's fingers will accomplish it. Difficulty in passing the finger behind the soft palate is to be met by inserting it at the lateral part of the palate, close to the tonsil. No force should be used. When the palate is passed, the beginner should be careful to pass his finger rapidly up to the roof, and feel for the septum, otherwise it may be grasped by the palate and never reach the vault at all.

For an examination of the accessory cavities of the nose the reader is referred to p. 411.

2. Nose: Local Anæsthetics

The drugs that may be employed for the induction of local anæsthesia of the mucous membrane of the nose and naso-pharynx are *menthol, cocaine, eucaine,* and *chloretone;* in connection with these, for reasons to be presently stated, mention should be made of the liquid extract of the suprarenal gland.

The above drugs possess, in varying degrees, an ischæmic as well as an anæsthetic action, and their relative value depends upon the purposes for which they are required. The points to be considered are:—(i.) Strength of solution required; (ii.) Method of application; (iii.) Rapidity, intensity, and extent of anæsthesia produced; (iv.) General and local action upon the circulation; (v.) After effects.

Menthol is of service in relieving local irritation and congestion, and is employed in oily solutions of ten to thirty grains to the ounce by means of a spray. The anæsthesia, compared with that produced by cocaine and eucain, is slight and insufficient to permit of it being used in surgical work.

Cocaine.—The strengths of solutions commonly recommended are excessive. For the purposes of examination of the nose, or the passing of a Eustachian catheter, a 5 per cent solution of the hydrochloride of cocaine may be used, but a 2 per cent solution, if freshly prepared, will generally produce sufficient anæsthesia and ischæmia. For operative purposes the strength of the solution should be from 10 to 15 per cent. It is important to remember that cocaine when kept in solution loses its anæsthetic action.

Upon the method of application of the drug will largely depend the degree of anæsthesia produced, and consequently the degree of discomfort afforded to the patient, and the facilities to the operator. A spray used in the nares will not produce so uniform and localised an anæsthesia as a saturated pledget of cotton wool carefully adjusted to the part to be treated. Moreover, sprays involve a waste of the drug, and are no doubt responsible for not a few of the toxic results. Speaking generally, a globular pledget introduced on forceps is not so efficacious as one spindle-shaped. A spindle-shaped pledget, an inch to an inch and a half in length, can be conveniently made by lightly wrapping absorbent wool round the tapering end of a small whalebone probe, which after being dipped in the solution of cocaine can be slipped into the nose so as to lie parallel with the turbinate body, the pledget being steadied with the points of forceps whilst the whalebone probe is withdrawn. For post-nasal and naso-pharyngeal operations local anæsthesia may be obtained by dropping the solution directly upon the part to be treated from a long straight nozzle of a syringe passed through the nares, the head being thrown backwards.

Cocaine is perhaps more rapid and intense in its action than eucaine, and on that account may be regarded as the better anæsthetic; but it has its drawbacks which will be presently mentioned. Gray[1] has pointed out that these drugs are more penetrating when dissolved in equal parts of dilute alcohol and aniline oil, and recommends a solution of five parts of cocaine dissolved in this vehicle for induction of anæsthesia of the ear. This solution he finds penetrates the tissues without destroying them, and produces a more complete anæsthesia than the aqueous. Unfortunately, alarming symptoms of prostration, pallor, and cyanosis may follow, which must be ascribed to the toxic effect of the aniline oil.[2] Another useful solution is a 5 per cent in equal parts of glycerine and rectified spirit.

Cocaine is a vaso-constrictor, and produces that ischæmia so serviceable both in investigating and treating diseases of the nose. Unfortunately, it has a depressing action on the heart, which may give rise to most untoward symptoms and inconvenience to the operator. In prescribing it for the patient's own use one has to bear in mind the possibility of a vicious habit being acquired. The disturbances of sensation caused by the anæsthetic action of the drug may persist for hours, or even days, so that some patients prefer the small amount of discomfort occasioned by minor manipulations, such as the passage of an Eustachian catheter, to the after effects of the drug. The toxic symptoms when they arise may be combated with inhalation of the vapour of nitrite of amyl and stimulants.

Eucaine.[3]—What has already been said in speaking of cocaine, with reference to the strength of solution and the method of application, is applicable to the use of eucaine. Local anæsthesia is perhaps not so rapidly produced by eucaine as by cocaine, and it may be that proportionately as the drug is less toxic it is also less powerful.

Upon the application of a 5 or 10 per cent solution of eucaine to the mucous membrane, hyperæmia occurs as an immediate result; this is in the majority of cases but an initial blush, rapidly passes off, and gives place to an ischæmia which, as seen in the nose, is generally less marked than that produced by cocaine. It is unusual to meet with excessive or unexpected hæmorrhage following operations done under eucaine anæsthesia, such as is not uncommonly met with after the use of cocaine; this is no doubt accounted for by the action of eucaine upon the peripheral vessels already alluded to. Associated with the initial hyperæmia is an increased salivation.

The after effects of eucaine are less unpleasant than those produced by cocaine, and are more transient. Those who have experienced the effect of both drugs have expressed a decided preference for eucaine. Eucaine is free from the toxic potentiality of cocaine, and is, therefore, of considerable service as an efficient substitute in cases in which an idiosyncrasy for cocaine would preclude an operation.

Chloretone is acetonchloroform, or trichlor tertiary butyl alcohol. It is formed when caustic potash is slowly added to equal weights of chloroform and acetone. Locally it acts like cocaine as a peripheral anæsthetic, and is said to be free from the depressing effects. It also possesses antiseptic properties, and has been found of service in preserving solutions of suprarenal gland. Sufficient time has not yet elapsed to determine its true value relatively with the other local anæsthetics.

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[1] *Lancet*, April 21, 1900, vol. i. p. 1125.

[2] *Lancet*, April 20, 1900.

[3] *British Med. Journal*, Jan. 16, 1897, vol. i. p. 134; Nov. 27, 1897, vol. ii. p. 1560.

Liquid extract of the suprarenal gland is perhaps the most powerful vaso-constrictor we possess, and on that account must be mentioned here. When applied to the mucous membranes the parts are shrunken and rendered bloodless, and this renders it specially valuable in controlling hæmorrhage and obtaining a comparatively bloodless field in nasal surgery.

The ischæmia it induces gives it a special value in the treatment of hay fever, as its local effect can be repeatedly obtained without the risk of entailing the vicious habit of cocaine.

It is very important that the solution should be freshly prepared, and this has hitherto been an impediment to its use. The difficulty has been met in two ways: by the addition of a preservative, such as chloretone, to the aqueous extract; and by supplying it in small cylindrical glass capsules known as "hypodermules,"[1] each containing one cubic centimetre of a standard solution sterilised in a manner which will retain its properties unimpaired for a lengthened period.

3. Diseases of Nasal Orifices and Septum

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AFFECTIONS OF SEPTUM NASI . 375
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SKIN AFFECTIONS OF THE VESTIBULE

THE affections of the orifices of the nose or vestibule are more properly described under the headings of the various skin affections; yet it will be opportune to mention the principal skin diseases that are here encountered, if only for the sake of a completeness in local classification. The commonest is eczema, which we find principally as the result of the constant exposure of the skin to irritating discharges, the most common of which is that of ordinary rhinorrhœa. This is most commonly found in young children suffering from acute or chronic rhinitis, when the resulting eczema of the vestibule may be associated with an external herpes. When due to these causes it is usually seen as a moist, inflamed, and sore surface with little or no itching. In the more chronic ailments of the nose it is not common to find, at the anterior and posterior angles of the nostril, minute fissures apparently extending hardly to a greater depth than that of the epithelium, which nevertheless are extremely painful and obstinate in healing. Rarely do we find the chronic forms of eczema such as affect the external auditory meatus and are dependent upon constitutional rather than local causes. Yet now and again we see a chronic eczema associated with what appears to be sycosis involving the hair follicles, when indeed the patient suffers from considerable swelling of the nose and extreme pain in the region of the follicles affected. The latter may also be the initial site of a septic process responsible for the necrosis of so much tissue as to induce true furunculus. The prognosis of such affections is necessarily guided by general principles, though so far as an eczema is dependent upon acute or chronic rhinitis a cure of the skin affection will necessarily depend upon the removal of its ætiological factor. In treatment we are guided again by general principles, the main endeavour being to protect the irritated skin from the discharge flowing over it. There is no better local application for this purpose than the vaseline of commerce, though it is often advisable to use it in conjunction with oxide of zinc, or with a few grains of calomel. A convenient plan is to dilute the zinc ointment with an equal part of paraffinum fluidum, which makes it of such consistence that it can be applied with a camel-hair brush. Where the eczema is associated with suppuration about the hair follicles the diluted nitrate of mercury ointment is sometimes used with benefit, while sulphide of calcium may be occasionally given with great advantage. Of course, where furunculus is forming, hot fomentations must be used freely and incision made as soon as pointing is defined.

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[1] *Journal of Laryngology*, vol. xvi. June 1901.

Other skin affections of the vestibule of the nose, such as lupus and other infective processes, are occasionally met with in conjunction with the same affections of the adjoining mucous membrane; and of course their treatment must be guided by collateral indications.

Affections of the Septum Nasi

Affections of the septum nasi may be classified according as they are simply malformations, or are definitely pathological. Probably there are no congenital malformations; for the various distortions and thickenings of the septum, whether cartilaginous or bony, are never seen during the first few years of life, seldom indeed under the age of seven; though it is well to remember that there may exist the congenital, more or less complete, occlusion of the posterior nares by a membranous partition.

The only pathological conditions of any importance, apart from hypertrophy of the erectile tissue which will be discussed in its place, are abscess and perforation. Abscess is occasionally met with as the result of traumatism, the immediate cause being a compound comminuted fracture of the triangular cartilage. Occasionally by such septic process the whole of the cartilage is sometimes destroyed, leaving the nose permanently deformed. The rhinoscopic appearances are peculiar: the nostrils obstructed by a smooth, fluctuating tumour, symmetrically disposed on the two sides, is characteristic enough for easy diagnosis, though of course the fluctuation may be caused by effused blood at a stage prior to the onset of suppuration. The only treatment is to open the abscess on both sides and pass a drainage tube through the septum so that it may emerge at both nostrils. The abscess-cavity can then be irrigated until perfectly sweet with some common antiseptic fluid. Abscesses may also probably arise from other causes, such as tubercle or the breaking down of a gumma; but in this case, although the triangular cartilage may be completely destroyed, no malformation of the nose will result provided neither the nasal bones, the perpendicular plate of the ethmoid, nor the vomer are involved. Indeed, perforations of the triangular cartilage are not uncommon, and may follow typhoid, scarlet, and possibly other fevers. Sometimes they are the result of ulceration, induced by constant removal of the inspissated mucus with the finger, and then are often associated with epistaxis. When involving the bony septum they are generally syphilitic, though I have good reason for believing they may follow influenza and possibly even simple catarrhal processes.

Malformations of the septum arise owing to some irregularity in the development process. It would appear that the septum having arranged for a certain extent of growth in a vertical direction, and for a certain degree of prominence in the nose, became arrested in such endeavour by the lack of corresponding enlargement of the nasal fossæ themselves in their vertical diameter. Thus, should the septum continue its attempts at extending after its limits have been fixed, it will spend itself by developing in other directions; and in this manner may be accounted for the deviations of the septum which are so common, as well as the ridges and spurs so frequently responsible for nasal stenosis.

The deviations in themselves are generally of less importance than the thickening at the angle of deviation on its convex side; and the obstruction thereby produced can generally be corrected sufficiently by paring with the knife or saw the actual thickening. Such thickenings, whether cartilaginous or osseous, are often out of all proportion to the amount of deviation, and assume such a size that they may block more or less completely the fossæ by pressure on inferior or middle turbinal. Indeed, spurs and ridges are often found without deviation, when they generally extend in a direction upwards and backwards, following the line of union between the vomer and the perpendicular plate of the ethmoid.

It is unnecessary to speak of the symptoms induced by these septal malformations, seeing that they do not differ from those appertaining to other forms of nasal stenosis, which are discussed at length under the article devoted to "Adenoids." For frequently recurring catarrhs, whether of nose, larynx, bronchial, or Eustachian tubes, a spur may often be held responsible. Occasionally irritation in the antrum of Highmore is caused by such pressure of a spur; while many a case of obstinately recurring polypus proves rebellious until such an obstruction is removed. Similarly paroxysmal sneezing and asthma may be ascribed to stenosis of the fossæ.

The treatment is necessarily surgical, and the removal of ridge or spur must be carried out boldly. The handiest instrument for most cases is Bosworth's saw, which serves equally well for bone and cartilage. The destruction of mucous membrane entailed is of little consequence provided it is not removed too freely from the anterior part of the triangular cartilage; and it is of no great consequence if a perforation of the septum is inadvertently produced. When the growth of cartilage is so far forward as to block the vestibule it is preferable, when possible, to save the mucous membrane. This can be effected by turning up a flap with the raspatory and slicing away the cartilage beneath. The disadvantage of a scar in this situation lies in the fact that the mucus tends to dry and adhere to it, thus causing a good deal of irritation and often epistaxis in the act of cleaning the nostrils, whether with the finger or by blowing.

For simple deviations without definite ridges various procedures have been advocated, the only satisfactory operation being that of Dr. Asche of New York. It consists in making a stellate incision over the deviation with scissor-forceps devised for the purpose, and then with a special instrument seizing each triangular piece and fracturing it at its base, thus allowing it to lie in a vertical position without the help of splints; indeed, this is the only way in which a corrected deviation can be insured against returning to its former position as soon as the pressure of retaining splints is removed. Yet even in Asche's operation it is advisable to fix in the nares suitable plugs for two or three weeks. Occasionally small spurs and ridges must be removed with a saw or knife before making the stellate incisions. In all such operations on the septum it is necessary to watch the case during healing on account of the frequency with which the granulations fungate and prevent cicatrization.

The inflammatory affections of the septum consist in hypertrophies of the erectile tissue over the triangular cartilage, which take forms precisely like those found over the inferior turbinals, and sometimes develop even true papillomata,[1] and of ulceration and perforation either of cartilage or bony septum. Such ulcerations are for the most part found over the anterior part of the triangular cartilage, and are due to the long-continued irritation and atrophy of the mucous glands, thus changing the normal membrane into a thin, friable, dry skin, upon which collects and dries the mucus flowing from adjacent parts. In the removal of this inspissated mucus with handkerchief or finger the friable surface is torn, and thus, by a constant repetition of this process, ulceration is induced, which in its turn leads to necrosis of the cartilage and perforation. Although this is the ordinary course in the production of a perforation, there is no doubt in my mind that simple catarrhal ulceration of the mucus membrane covering the septum also may lead to perforation in regions inaccessible to traumatic influence, and on which the mucus will not actually dry. Such perforations, it is said, are found sometimes after typhoid, scarlet fever, diphtheria, etc. Syphilis is, of course, the commonest cause of destruction of the bony septum, although by far the majority of perforations of the cartilage are not syphilitic, as used formerly to be supposed.

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[1] *Vide* article on "Benign Growths of the Nose."

The treatment of hypertrophy of the erectile tissue must be conducted upon general principles, removing it with snare or otherwise destroying it with the electric cautery. The ulcerations must also be treated upon common-sense grounds, the prime object being to prevent the accumulation and drying of the mucus over the sore surface. Nothing is better for this purpose than a semifluid zinc or boric acid ointment. Occasionally, of course, caustics may be used with advantage, and none is more useful than chromic acid in a 10 per cent solution.

BENIGN TUMOURS OF THE NASAL FOSSÆ

The ordinary benign tumours of the nose are comprised under two headings: First, those consisting in hypertrophy of the erectile tissue, and confined for the most part to the inferior turbinals and the anterior part of the septum; and, second, those ordinarily called polypus, which spring from various parts of the ethmoid. All these are unquestionably of inflammatory origin, although in many text-books of surgery they were till lately described as adenomata or myxomata. The former term apparently included the true hypertrophies of the inferior turbinals, seeing that the mucous glands, together with the other elements, undergo hypertrophy, while polypus, being œdematous fibroma, was readily mistaken for true myxoma. They are always associated with a catarrhal condition, and undergo fresh increase of size whenever inflammation is set up, whether from the contraction of cold or from the use of irritating measures of treatment.

(1) Hypertrophies of the inferior turbinals must be distinguished from mere vascular engorgements of the venous sinuses. The former always present a more or less lobulated appearance, often producing growths of cauliflower-like appearance, so much so, indeed, that they are frequently mistaken for papilloma. On the other hand, mere vascular engorgment, although it may attain such size as to fill completely both inferior and middle meatus, is invariably smooth and globular on the surface, while it pits to a curious degree on manipulation with a probe. The application of cocaine causes rapid shrinking of the tumefaction, while it has little or no effect upon the hypertrophic condition. The two, however, are frequently associated, and both may present all degrees of colour from bluish white, under conditions of local or general anæmia, to a dark mulberry colour, seen especially in those posterior hypertrophies which project into the post-nasal space. The symptoms are, of course, identical with those produced by any

form of obstruction, although it appears to me, from my own experience, that these hypertrophies of the inferior turbinals are more clearly productive of asthma than other forms. And this I maintain, although polypus is more often associated with asthma; for both the latter being expressions of a common inflammatary action involving the whole respiratory tract, do not appear to stand to one another in the same relation of cause and effect. The distinction is a purely clinical one and of importance in prognosis, although the statement is difficult to substantiate on theoretical grounds. As far as local symptoms are concerned these hypertrophies are always associated with much catarrh, and a greater degree of difficulty in extruding the secretion than is accounted for by the actual amount of obstruction to breathing. Mucus is often seen lying imprisoned in the inferior meatus in ropy, tenacious masses, which the patient is unable to remove by any amount of blowing. The hypertrophied masses may attain such a size as not only to fill inferior and middle meatus, but also to encroach very considerably upon the post-nasal space. Indeed, when adenoids are present also, as sometimes happens, the post-nasal space may be completely filled.

The diagnosis between these hypertrophies and mere vascular engorgements I have already related, while they may be as easily distinguished from polypus by the translucency, mobility, and uniformity of the latter. The treatment consists in the removal of the redundant tissue by means of the cold or incandescent snare. My preference is for the former, as it excites less inflammation in the surrounding parts, while, if so constructed as to constrict the growth very slowly, there need be no more bleeding than in the use of the incandescent snare. Minute hypertrophies may be suitably destroyed with the cautery point, though such treatment is too slow for the larger masses. The operation of turbinectomy need only be mentioned to be condemned; for it artificially produces an atrophic rhinitis with many of its attendant miseries, more especially dryness of the pharynx and larynx. But it is an operation more easily accomplished, and requiring less time than the careful trimming of an hypertrophied inferior turbinal to its normal limits, and so is much patronised in some quarters.[1]

For the posterior hypertrophies the snare is the only instrument; but in the anterior, scissors and forceps may often be used with advantage.

Finally, it may be mentioned that there is little or no tendency to a recurrence of these growths after complete removal.

(2) The benign tumours affecting the ethmoidal region, while all definitely inflammatory, are more complex in their ætiological appearance and habits than those just described. Thus we have simple mucous polypi, cystic mucous polypi, polypi associated with caries and suppuration in the accessory cavities, as well as osseous cysts and bony hypertrophies of the middle turbinals. Upon the pathological relations of these different inflammatory growths it is hardly necessary in this place to enter; suffice it to repeat that, although the older pathologists describe these growths as myxomata, it is now the fashion, and probably correctly so, to consider them as merely œdematous forms of all transitions between granuloma and fibroma. No true myxoma cells are ever met with. The growths are covered with ciliated epithelium, even when they are rather to be considered as œdematous granulations springing from a bed of ulceration. In the latter event the growths are always associated with suppuration; and when this is the case the prognosis should be guarded, seeing that the extent of

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[1] *Vide* author's presidential address in section of Laryngology, annual meeting of Brit. Med. Assoc., Montreal, 1898.

the mischief, and the question whether any accessory cavities are involved, often cannot be determined until the growths themselves are removed. Otherwise the prognosis is altogether favourable, provided the surgeon has skill to effect, and the patient the perseverance to wait, through eradication. Indeed, mucous polypi do not recur in spite of what is commonly believed, provided they are completely removed: and the possibility of effecting this depends upon the accessibility of the individual growths. For these growths are nearly always multiple, generally affecting both fossæ, while they involve chiefly the upper and lower surfaces of the middle turbinal. Cystic polypi are curiously different. They are solitary, seldom involve both fossæ, are situated far back in the middle meatus; and, so little sign is left after their removal of their precise situation, that it is impossible to effect satisfactory after-treatment as a guarantee against recurrence. Yet they often recur, rapidly attaining as before their removal enormous dimensions, so that, growing from one middle meatus alone, they may block both fossæ as well as fill the post-nasal space. They generally contain a thin, yellowish, transparent mucus resembling that found in retention in the antrum; while their walls, microscopically resembling the structure of multiple polypi, vary considerably in thickness. Whether these cystic polypi are originally obstructed mucous glands, or whether they are diverticula resulting from occlusion of some accessory sinus, which I strongly suspect to be the case, judging from the certainty and rapidity of recurrence, has not at present been determined.

Osseous cysts are not common, though they may attain such dimensions, distending the nasal bones, deviating the septum so as to block the opposite fossa, as may cause complete obstruction of nasal respiration. Their causation is obscure, some cases, I believe, being due to distension of the walls of the infundibulum from retention, and some to occlusion of the space formed by the incurving of the middle turbinal's free border.[1] At any rate they are lined with epithelium, and generally contain masses of atheromatous material. In one case I found the interior studded with small polypi. Such growths, of course, do not recur after removal, and the prognosis is always good, seeing that the tumours are readily amenable to surgical attack.

Osseous hypertrophies of the middle turbinals are sometimes of sufficient importance from the pressure they produce upon contiguous parts to necessitate removal. They are the results of simple osteophytic periostitis, and may or may not be associated with polypus. Hence also the prognosis, of course, is eminently satisfactory.

Such benign tumours, involving various regions of the ethmoid, may be encountered in patients of either sex or any age, though for the most part they are commoner in men and extremely rare in childhood. They are, as already remarked, the result of a catarrhal process, and hence are more frequent in those climates and latitudes which favour the catarrhal process. There is a well-marked hereditary proclivity, as there is to hay-fever and asthma. The symptoms caused by them are those simply of nasal obstruction, though we often have in addition symptoms arising from retention in the accessory cavities or from pressure on the nasal duct; consequently the eyes are often watery and sympathetically inflamed, while, probably from pressure on the lymphatic circulation, the patient's mental faculties are retarded in activity. Indeed, very curious mental conditions may be entirely removed by the cure of polypus, and I have known agoraphobia immediately cured and the faculties of memory and sleep greatly improved by such operations. Asthma, chronic bronchitis, and chronic laryngitis are frequent concomitants of nasal polypus, although, as I have said before, and judging from clinical experience, I believe that asthma must be considered an accompaniment rather than a consequence of polypi.

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[1] *A Treatise on Nasal Suppuration.* By Dr. Ludwig Grünwald (translated by W. Lamb, M.D.), 1900, p. 237.

Treatment.—The only treatment worth considering is operative, and although many local astringent remedies have been recommended, yet all, from powdered alum or tannin to absolute alcohol, have proved futile. The forceps were used entirely before the days of cocaine, and have still their value in removing large quantities when the patient is under a general anæsthetic; but for operating with cocaine, and where it is preferable to effect a clearance with a succession of operations instead of at a single sitting, one or other form of snare is to be preferred. An idea is prevalent in some quarters that the incandescent snare renders recurrence less likely, though there is probably no justification for such a surmise; and the same objection applies to it as in the use of the cautery-point for destroying these growths, namely, that steam is generated by its use and the surrounding structures inevitably scalded. Indeed, the cautery-point is only admissible when we can see precisely the limits of the growth to be destroyed, and can bury its point in the polypus, so that the latter itself will protect the adjacent parts. An extremely useful instrument for effecting the removal of very small growths which are quite accessible is the forceps of Heymann, while the curette and sharp spoon have their uses in removing small growths and granulations from the roof or outer wall of the middle meatus. Recently ablation of the middle turbinal has been strongly advocated as a help to the eradication of a polypus-producing mucous membrane; and in certain cases, more especially where the growths arise in the superior meatus or from the upper surface of the middle turbinals, it is justified. Nevertheless, it is becoming commoner than is justifiable when one remembers that it is not altogether devoid of risks. Meningitis has more than once followed the operation, and the cribriform plate has actually been fractured in the attempt. Moreover, it is seldom necessary to remove the whole structure, and its free margin can be safely cut off with scissors in one piece, or piecemeal with the punch forceps of Gruenwald or Symonds.

Important in the eradication of polypus is the removal of any adventitious source of obstruction. Septal spurs and irregularities may render access to the growths difficult or impossible, while hypertrophies of the inferior turbinals or of the erectile tissue of the septum must sometimes be removed or reduced before we can hope to minimise the tendency to cold-taking, which is the chief factor in recurrence. Although in this place it is not intended to consider constitutional causes which may predispose to a cold-taking, I cannot let the opportunity pass of insisting upon the fact that overclothing, imperfect ventilation of the living and sleeping rooms, are the two conditions oftenest responsible and at the same time most easily remedied.

MALIGNANT GROWTHS OF THE NASAL FOSSÆ

Malignant growths of the nose are rare, and are almost confined to sarcoma. Formerly it used to be asserted that mucous polypi occasionally became epitholiumatous. Thus Erichsen[1] wrote that after the extraction of benign polypi from the nose in children and young adults, sarcomatous, myeloid, or encephaloid tumours often supervene. Nevertheless the rhinologist of to-day is altogether unaware of such transformation. I have operated myself upon over a thousand cases, and never yet encountered such unfortunate results. Probably the original diagnosis was in fault, and the surgeon was dealing with those tumours which used to be styled fibrous polypi of the nasal pharynx, originating generally between the ages of fifteen and twenty-five, many of them undoubtedly malignant, and some presenting a sort of semi-malignancy. These tumours were fully described by Dieffenbach (1) in 1834; and since then many continental surgeons, *e.g.* Nélaton (2), Chassaignac (3), Langenbeck (4), Huguier (5), etc., have contributed to the operative treatment of these growths. Yet so rare is the disease in this country that Paget (6) tells us that he has never had an opportunity of examining these growths in the fresh state. Probably they would now all be classed as sarcomata, possibly with a smaller degree of malignancy than is met with in the same growths when occurring in patients of riper years. Indeed, it is said that, provided the growths can be held in abeyance till the patients have attained the age of five-and-twenty, they show a tendency to undergo spontaneous absorption. The disease is admittedly rare in females, though I have seen two instances in girls under thirteen years. The growths appear to originate at the base of the skull, either from the sphenoid or cribriform plate of the ethmoid. They extend into the fossæ, into the naso-pharynx, even into the accessory sinuses, and produce that separation of the orbits and flattening of the nose which has been likened to a frog's face. The symptoms are those common to all forms of nasal obstruction, with the addition of repeated and severe hæmorrhages, and not infrequently a tendency to prolonged and profound sleeping.

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[1] *Science and Art of Surgery.* By Erichsen, 7th edition, 1877

Sarcoma in older patients may originate in any part of the nasal fossæ. I have twice been able to localise it in the middle turbinals, once in the superior meatus, and once on the anterior extremity of the inferior turbinal. The prognosis of such growths is certainly not quite so grave as similar tumours in other parts of the body. Not to mention the statement already made, and of which I can give no personal assurance, namely, that after the age of twenty-five there is a spontaneous tendency on the part of the naso-pharyngeal fibrous polypi to undergo absorption, I have recorded a case of small-celled sarcoma of such extent that one of our most distinguished surgeons declined to operate, where nevertheless complete eradication was effected by intra-nasal treatment, and where, to my knowledge, the patient remained free of the disease for three years after the last operation. Consequently, provided such growth is accessible and presents a fairly localised point of origin, its actual size need not deter us from attempting eradication by intra-nasal operations. But the patient should understand that the surgeon must have an absolutely free hand for as long a time as he may think desirable. Nevertheless, most of these cases will fall into the hands of the general surgeon rather than of the rhinologist; and the operations for the removal of such growth, whether by splitting the hard palate or by the removal of the superior maxilla, fall under the domain of general surgery (see p. 167).

LITERATURE.—1. *Chirurgische Erfahrungen.* Berlin, 1834. Dritte und Vierte Abtheilung, p. 236 *et seq.*—2. Botrel. *D'une opération nouvelle diregée contre les Polypes naso-pharyngiens.* Paris, 1849.—3. *Traité des operations chirurg.* t. ii. p. 448.—4. *Deutsche klinik,* No. 48, 1859.—5. *Bull. de l'académie de méd.* Paris, May 28, 1861.—6. *Lectures on Surgical Pathology.* London, 1870; 3rd edit. p. 475.

4. Acute Inflammation of the Nose

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See also EPISTAXIS.

ACUTE RHINITIS.

Syn.—Coryza; cold in the head; acute nasal catarrh.

Definition.—An acute catarrhal inflammation of the nasal mucous membranes. This common affection may occur under different circumstances, *e.g.* it may constitute a malady in itself, or it may form an early manifestation of a more serious disease, such as congenital syphilis, influenza, measles, whooping-cough, and glanders; or, again, it may represent the main feature of conditions where neurotic and vaso-motor changes are predominant, as in hay fever and paroxysmal sneezing. Finally, symptoms resembling "a cold," and known as iodism, may result from the administration of iodide of potassium.

Ætiology.—Although the rapid onset, course, constitutional symptoms, and evidence of contagiousness of acute nasal catarrh render it highly probable that a specific micro-organism is the exciting cause, yet no such *materies morbi* has hitherto been discovered.

There are many well-known predisposing causes without one or more of which, the exciting cause would appear to be unable to precipitate an attack of acute rhinitis. Among the more important of these may be mentioned: (*a*) Pathological conditions of the nasal mucous membranes and cavities, *e.g.* various forms of hypertrophic rhinitis, polypi, septal spurs, crests, and deviations, all of which produce obstruction to nasal respiration; (*b*) Sudden changes of temperature from hot to cold, and *vice versa;* (*c*) Nervous exhaustion; (*d*) Bodily fatigue, especially when this supervenes upon free perspiration; (*e*) Draughts of cold air blowing upon a heated or perspiring skin; (*f*) An hereditary tendency to acute nasal catarrh.

In conditions of health the nasal mucus is said by Thomson and Hewlett[1] to inhibit the growth of pathogenic micro-organisms, very few of which are to be found within the nasal cavities, and possibly the predisposing causes, already enumerated, act by weakening in some way the protective properties of the normal mucous membrane and its natural secretion, so that the specific micro-organism of acute rhinitis not only flourishes for the time being within the nasal cavities, but gains an entry to the general system through the lining mucous membrane, and thus produces both local and constitutional symptoms. It is an interesting question whether, in some cases an entrance into the system may not be effected, in a similar manner, by the germs of those grave diseases which occasionally follow in the wake of a neglected cold.

Morbid Anatomy and Pathology.—There are swelling and hyperæmia of the nasal mucous membranes with increased cell proliferation and secretion. The fluid is slightly alkaline, contains traces of albumin, yields a precipitate with acetic acid (mucin), does not reduce Fehling's solution, and stiffens a handkerchief upon which it dries (cf. characteristics of fluid in cerebro-spinal rhinorrhea).

Symptoms.—The onset of acute nasal catarrh is usually marked by slight feelings of malaise associated with a sense of dryness, pricking sensations, or stuffiness within the nose. Sneezing is an early and rapidly becomes a prominent symptom, accompanied by the flow of a clear watery discharge from the nostrils. Owing to the irritating nature of the fluid and the constant use of the handkerchief, the skin around the nostrils and on the upper lip becomes red and sore, while not uncommonly herpetic vesicles make their appearance in this situation.

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[1] *Medico-Chirurgical Transactions.*

The swelling of the nasal mucous membranes produces nasal obstruction, necessitating mouth breathing with its added discomforts.

Frontal headache, pains in and around the eyes, and suffusion of the conjunctivæ, indicate the spread of the catarrhal process from the nose to surrounding structures.

The sense of smell is temporarily lost, and hence there is no appreciation of flavour, while extension of the catarrhal process into the naso-pharynx may produce occlusion of the pharyngeal orifice of the Eustachian tube, causing slight deafness and tinnitus, and possibly a little earache. If the inflammation actually passes into the tympanum, acute otitis media and its sequelæ may result.

The effect on the voice of this general swelling of the nasal mucosa is to destroy its natural resonance, rendering it toneless and deadened.

In young children, especially when nursing at the breast, nasal catarrh may constitute a serious condition, because it will entail great difficulty in feeding, owing to obstructed nasal respiration.

The acute symptoms of coryza may last from twenty-four to thirty-six hours, when they gradually diminish in severity. The discharge becomes more viscid and muco-purulent, and usually becomes quite purulent before the catarrh has entirely passed off.

A general sense of weakness and depression is apt to supervene upon the subsidence of the acute symptoms, while the spread of the catarrhal condition to the pharynx, larynx, and larger bronchial tubes is evidenced by hoarseness, cough, and muco-purulent expectoration, which symptoms may last from ten to twenty days after the commencement of the acute attack.

It should be borne in mind that during the first month of infant life congenital syphilis may first manifest itself in an attack of acute rhinitis, which is usually accompanied or shortly followed by the characteristic skin eruption most common about the buttocks. The nasal discharge, at first clear, quickly becomes purulent and dries around the nostrils, producing soreness and superficial ulceration, while the nasal obstruction caused by the disease renders the proper nourishment of the child a matter of great difficulty (*vide* "Congenital Syphilis"; for nasal symptoms of hay fever, *vide* art. "Hay Fever").

Prognosis.—This is nearly always good, but in young children and old people a cold in the head, especially when neglected, is often followed by bronchitis, or other acute diseases of graver significance.

Constantly recurring attacks of nasal catarrh tend to weaken the resistance of the nasal mucous membranes, so that at last a condition of chronic rhinitis is produced, characterised by hypertrophy of the nasal mucosa, nasal obstruction, excessive secretion, and various other symptoms (*vide* Chronic Rhinitis).

Furthermore, acute rhinitis is often the starting-point of acute and chronic suppurative inflammations of the nasal accessory sinuses; especially may this be the case so when the nasal catarrh is associated with influenza, the acute specific diseases, or the patient lives among insanitary surroundings. Probably in all cases of acute coryza the catarrhal changes spread into the frontal, ethmoidal, and maxillary sinuses, but, as a rule, the inflammation subsides with the general subsidence of the catarrhal process.

Treatment.—This may be considered under the headings of (*a*) prophylaxis, (*b*) general and local treatment.

(*a*) Prophylaxis.—A person subject to acute nasal catarrh can do much by care to render the attacks less frequent by the avoidance, or remedying of those predisposing causes to which allusion has already been made. A cold bath in the morning, followed by the use of a rough towel, is an excellent method of rendering the body less sensitive to changes of temperature.

In children, old people, and those with feeble circulation, and in others where a cold bath is followed by white fingers and a sense of chilliness or headache, the water should be used lukewarm, and followed by a momentary cold douche. Nothing renders a person more susceptible to "cold" than undue wrapping up or "coddling" of the body. Under such circumstances perspiration is easily produced, and the liability to catching cold increased. Some form of wool should be worn next the skin, a thinner or more open texture in summer than in winter. Neckwraps are rarely necessary. Bed-clothes should be light and warm, and even in winter counterpanes are unnecessary.

With regard to the daily routine of life, there is little doubt that overfed, plethoric, sedentary individuals are more liable to colds than spare and active people who live plainly and spend a considerable portion of their time in the open air.

(*b*) General Treatment.—When a cold commences active treatment must be instituted at once if it is to be of any avail. Most people agree that diaphoresis is advantageous, and, furthermore, that opium or one of its active principles is the best means of promoting that end.

The drug should be administered in the early stage of a cold before free discharge occurs, and, if possible, it should be given on a nearly empty stomach. Ten grains of Dover's powder at night, followed by a cup of hot tea or hot lemonade, spirits of nitre, or hot whisky and water, is an old-fashioned and excellent remedy. Others prefer a pill of sulphate of morphia, gr. $\frac{1}{3}$, during the early evening, and a second on going to bed, followed by a hot drink. The next morning 5 grains of quinine may be taken with advantage.

When the discharge is free the opium may be combined with diuretics, *e.g.*, tr. opii ♏ xv., spir. ætheris nitrosi ʒj., liq. ammon. acetat. ʒiij., aq. camphoræ ad ℥j. To be taken at bed-time in an equal quantity of warm water.

The patient should keep indoors and in a warm room, but well ventilated. Should the opiate cause headache, furred tongue, or nausea, a saline aperient will be beneficial.

When catarrhal symptoms are accompanied by severe headache and general muscular pains, the salicylate of soda may be conveniently substituted for the opium in the above prescription, and of the mixture one ounce should be taken every four hours until the pain is relieved.

In children and young people generally aconite has been highly recommended. It may be prescribed in pilules containing $\frac{1}{480}$ gr. of aconitine, one of which may be taken every two hours for three doses; or the tincture of aconite, one minim every half hour for three or four doses, may be substituted for the alkaloid.

As a general rule this drug acts quickly and well if it is going to act at all, and it should only be given in the early stage of febrile affections (Yeo).

From personal experience the writer can testify to the great diminution of the nasal discharge brought about by abstention from liquids. An occasional tea-spoonful of lemon water is quite sufficient to assuage thirst for the twelve hours or so during which the rhinorrhea is profuse.

The hypodermic injection of $\frac{1}{120}$ to $\frac{1}{60}$ gr. of atropine sulphate has been recommended, but hypodermic medication is open to objection on so many grounds that the writer cannot advise it for so universal a disease as that under discussion.

Camphor pilules, or a few drops of spirits of camphor on a lump of sugar, are popular remedies for the early stages of a cold, but experience as to the efficacy of the drug varies very much in different cases.

Local Treatment.—The very number of remedies recommended for the local treatment of a "cold" is sufficient guarantee that no one of them is universally applicable. Eucalyptus oil inhaled from a handkerchief is highly praised by some for its abortive effect upon a commencing cold, while others are equally enthusiastic of the virtues possessed by certain "anticatarrhal smelling salts," *e.g.* ac. carbol. gr. 30, ammon. carb. ℥j., pulv. carbo. lejn. ℥j., ol. lavand. ♏xx., tr. benzoin. co. fl. ʒss. M. Medicated steam inhalations often give relief to the nasal discomfort, and of these camphor is one of the best. One drachm of the "spirits of camphor" is added to a pint of boiling water contained in an inhaler or narrow-necked jug, and the vapour inhaled through the nostrils for periods of five to ten minutes twice an hour.

Menthol has been similarly recommended, some 10 to 15 drops of a 10 per cent alcoholic solution of menthol are added to a pint of nearly boiling water, and used as above. A nebulised spray of menthol dissolved in liquid paraffin (x.-xv. grs. ad ℥j.) and used from an atomiser has been highly recommended to relieve the obstruction of the early stages of nasal catarrh, but my own experience is that although temporary freedom of nasal respiration is obtained by this means, yet the discharge is afterwards increased and also the soreness of the nostrils. Cushmann's menthol inhaler enables the dry vapour of the drug to be used, and can be carried about in the waistcoat pocket.

Cocaine in from 4 to 10 per cent solution undoubtedly gives the very greatest relief to the nasal obstruction, and it is longer than that obtained by any other means. For this reason it has been highly recommended by some physicians, who do not hesitate to prescribe it for patients to use themselves. Many cases of the cocaine habit have been induced in this way, and those who have witnessed the terrible mental and moral effects characteristic of chronic cocaine poisoning will agree with the writer that the very greatest circumspection should be used in ordering the drug.

It may be used without fear in little children where nasal obstruction prevents nursing or feeding. In such cases a few drops of a 5 per cent solution in olive or castor oil may be dropped from a pipette into each nostril five minutes before feeding-time.

Nasal douches should never be used during the acute stages of nasal catarrh, but when the secretion has become muco-purulent or purulent an alkaline wash is useful, comforting, and hastens the return of the mucous membrane to its normal condition. Such a wash may be composed of potass. chlor., sod. bicarb., sod. bibor. āā ʒss., sacc. alb. ℥j. One teaspoonful in three-quarters of a tumblerful of lukewarm water may be used as a nasal wash night and morning. Such a lotion can be sniffed up the nostrils from a saucer or injected by means of a suitable nasal syringe. The combination of drugs used in the preparation of many favourite nasal washes may now be obtained in compound form.

The depression and general malaise following a cold are best combated by tonics, such as Easton's syrup, or syrup of the hypophosphites, while the intervals between successive attacks may often be lengthened by periodically taking small doses of arsenic.

FIBRINOUS RHINITIS.

Syn.—Membranous croupous rhinitis.

An inflammation of the nasal mucosa of an infectious nature characterised by the formation of a membranous exudation on their surfaces. The fibrinous membrane, usually limited to the nasal cavities, is more or less firmly adherent to the underlying mucous membrane, and its removal may cause slight hæmorrhage. Lack[1] has shown that this disease is caused by an organism identical with the true Klebs Loeffler bacillus.

The symptoms are often no more than those characteristic of a severe head cold associated with nasal obstruction; in fact the disease may be only recognised by the expulsion of membranous shreds from the nose. The secretion may become muco-purulent and fœtid, and if unilateral will closely resemble those associated with a foreign body in the nose. Epistaxis may occur as a late symptom.

Treatment.—The expulsion of membrane should be hastened by warm alkaline antiseptic sprays, but not forcibly removed. The nostrils may be swabbed out once daily with a mixture composed of lactic acid 2 parts, carbolic acid 3 parts, and glycerine 30 parts. The child should be isolated as far as possible, to avoid spread of infection.

ACUTE SUPPURATIVE RHINITIS.

Purulent nasal discharges of acute onset are most commonly met with in infant life. The newly-born may be infected by a gonorrhœal or leucorrhœal discharge in the mother. In such cases the nasal mucosa are acutely inflamed, and the purulent acrid discharge rapidly produces excoriation of the skin about the nostrils and of the upper lip. The conjunctivæ are very liable to infection. Carelessness in adults may also result in the nasal mucosa being infected by a gonorrhœal discharge.

Bosworth describes a purulent rhinitis of childhood which he regards as a precursor of atrophic rhinitis. The writer has no experience of such cases. A puriform nasal discharge of rapid onset may be met with in glanders and in the exanthemata, while the same symptom is one of the commonest evidences of congenital syphilis (*vide supra*).

In adults, apart from gonorrhœal infection, acute suppurative rhinitis may occasionally complicate the specific infectious diseases, and may also result from the use of septic instruments employed in intra-nasal operations.

Treatment.—In addition to appropriate constitutional treatment the nasal cavities should be constantly cleansed by suitable antiseptic sprays, *e.g.* sodæ bicarb. grs. 10, ac. carbol. gr. 1½, sodii chlorid. grs. 3, aquæ ℥v. Such sprays should be always used at the body temperature. Another excellent wash is that already advised for the late stages of acute rhinitis (*vide supra*).

5. Chronic Inflammation of the Nose

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1. CHRONIC RHINITIS, SIMPLE AND HYPERTROPHIC

SIMPLE chronic rhinitis may be described as a chronic inflammation of the whole of the mucous membrane lining the nasal cavities. It is so often accompanied by hypertrophic changes that the two diseases (simple and hypertrophic rhinitis) may be conveniently considered together.

Ætiology.—Chronic rhinitis often has its origin in repeated attacks of acute nasal catarrh, especially when the form of the nasal cavities (deflections or spurs of the septum) predisposes to retention of the products of inflammation. Congenital narrowness of the nasal passages, causing the turbinated bones almost to touch the septum, and a high arch to the palate, also favour chronic catarrh. In other cases it is caused by the entrance of irritants into the nose, such as tobacco smoke, snuff, particles of coal smoke, and the irritants generated in certain trades, *e.g.* those of millers, tobacco workers, stone-masons, etc., and those found in certain chemical factories where ammonia, sulphuric acid, bichromate of potash, and other irritants are produced (coryza professionalis). In abscesses of any of the accessory sinuses the nasal mucous membrane is also kept in a state of chronic catarrh. Furthermore, growths in the naso-pharynx, such as adenoid vegetations, may give rise to chronic rhinitis, as well as foreign bodies in the nose and rhinoliths.

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[1] Lack, *Med. Chir. Trans.*, vol. lxxxii.

As predisposing causes for chronic coryza are enumerated: syphilis—especially congenital occurring in children—scrofula, and gout. Chronic rhinitis is commoner in men than in women, in the proportion of two to one (Klemperer). This is attributable to their occupations and habits.

Pathology.—According to Hajek and Klemperer[1] bacteria play but a subordinate part in chronic rhinitis; it is therefore not to be regarded as an infective disease. Bacteria have never been detected in the mucous membrane itself. Those present so abundantly in the secretion are, according to Klemperer, simply those found in the normal nose, which have enormously increased in number in the profuse and pathologically changed secretion. This does not, of course, apply to some forms of subacute purulent rhinitis, especially to gonorrhœal rhinitis, and possibly to that accompanying certain acute infectious diseases.

The microscopic appearances consist (Klemperer) of a considerable cellular infiltration of the epithelium and subepithelial tissue, especially in the latter case round the glands and vessels. The epithelial layers are increased, the upper layers have become more cubical or flattened, and the ciliated cells are only present in places. The cavernous spaces are dilated; the connective tissue is scarcely increased. After a time the swelling of the mucosa increases and becomes more localised; the diffuse swelling becomes a circumscribed thickening. The parts most commonly affected in this manner are the posterior and anterior ends, and the lower margins of the inferior turbinated bodies; less frequently, the middle turbinated bodies, the floor, and the septum. The thickenings may be of a dark purple colour, or whiter, from thickening of the epithelium and connective tissue. They may be markedly papillary in character, or the papillæ may be only visible with a lens. Microscopical examination of the thickened portions shows a distinct increase of the connective tissue, also often of the vessels and glands. The epithelium exhibits the same changes as those already mentioned, but the layers are much more numerous, while the cellular infiltration is much less marked. Subepithelially firm connective tissue is always present in considerable quantity.

Various names have been given to these thickenings, according to the preponderance of different elements in their structure, and also according to their external configuration. As there is no unanimity on the subject amongst observers, Klemperer suggests that they should all be termed "thickenings," diffused or circumscribed, temporary or permanent, the latter being divided according to their shape into polypoid, lobed, papillary, etc. Zarniko, on the other hand, prefers to call them all "fibromata," as the connective tissue is always increased. In ninety-nine times out of a hundred, the term "hypertrophy" cannot, strictly speaking, be applied to them (Zarniko), because (1) they do not exhibit a simple excess of normal growth corresponding in structure to the normal tissue, and (2) they do not exert the functions of the normal organ in an increased degree.

Symptoms.—Stoppage of the nose and discharge are the symptoms chiefly complained of. The nasal obstruction may be one or both sided, temporary or permanent, and may alternate. It may be caused not only by structural changes, but by accumulation of secretion, which may be mucous, muco-purulent, or purulent in character. Other symptoms are:—Loss of smell (anosmia), partial or complete, loss of taste of flavours (less frequent), excessive sneezing, sensation of pressure or weight in the nose, headache, epistaxis, loss of resonance of the voice (due to the nasal obstruction). A sensation of dryness and burning in the nose is sometimes present.

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[1] *Handbuch der Laryngologie und Rhinologie.* Ed. by Dr. Paul Heymann, 1900, vol. iii. p. 384. Article on "Chronic Rhinitis."

Examination of the Nose.—Examination of the nose reveals in the simple form of chronic rhinitis a general redness and fulness of the mucosa, which has lying upon it in parts more or less mucous or muco-purulent discharge. In old-standing cases the mucous membrane is sometimes unusually pale. There is generally more or less turgescence of the erectile tissue on the inferior turbinated bodies, and when this is very marked and accompanied by violent sneezing and watery discharge, the term "vasomotor rhinitis" is applied to the disease. The diagnosis between true thickenings (hypertrophies so-called) and erection is made by means of cocaine, which reduces the latter and not the former. The thickenings also often appear distinctly papillary, and can be moved about with a probe, *e.g.* on the lower margin of the inferior turbinated body. When seen from behind the inferior turbinated body often has a mulberry-like (moriform) aspect. The diagnosis can also be completed by palpation of the choanæ. Thickenings at the back of the septum are not unusual. On the floor near the front they are most common in my experience in cases of a vasomotor character.

Complications and Results.—The naso-pharynx, the pharynx, and even the larynx are often also affected, partly owing to the same source of irritation acting on them, partly from the mouth-breathing, which is naturally present when the nasal obstruction is at all marked. Various reflex nasal phenomena occur, such as sneezing and watery discharge (as already mentioned), neuralgia, asthma, nasal cough, aphonia, laryngeal spasm, etc., also eczema of the vestibules, affections of the external nose in the form of redness and thickening of the tipæ, the latter being probably partially reflex. The eye may be implicated through the lachrymal duct, causing affection of the lachrymal apparatus. Conjunctivitis (simple and phlyctenular), keratitis, etc. have been described in connection with chronic rhinitis. Ear complications are still more common, and may be roughly said to be due either to the nasal obstruction interfering with the proper ventilation of the tympanic cavities, or to an extension of the catarrh through the naso-pharynx up the Eustachian tubes. Diseases of the accessory sinuses may result from chronic coryza, but probably the reverse is more commonly the case.

Diagnosis.—The diagnosis is usually easy, the most important point being to ascertain whether, in addition to the nasal catarrh, any other affections are present, such as disease of the accessory sinuses or tumours, also the absence of any chronic infective diseases as syphilis and tubercle.

Prognosis.—The prognosis depends chiefly on the causation of the disease, whether removable or not. The disease is not dangerous except in young children, when the nasal obstruction may interfere seriously with their nutrition. On the whole the prognosis is favourable when the disease is suitably treated.

Treatment.—*In simple chronic coryza* the first essential is the removal of any existing source of irritation, whether it be introduced from without or be an intra-nasal irritant (see above, "Ætiology"). The secretion should be removed by regular cleansing of the nose by the patient: this may be accomplished either (1) by sniffing up a liquid from a vessel or the palm of the hand, and ejecting it through the mouth; (2) by using a glass syringe provided with an olive-shaped nozzle; or (3) where there is much discharge, by the use of a Higginson's syringe with a similar nozzle.[1] In the two latter cases the syringe should only be inserted into the narrower nostril, and the patient be directed to breathe through his mouth, and not to swallow while the liquid is in his nose. The simplest and best liquid to use is a warm normal solution of chloride of sodium (*i.e.* ·73 per cent, or a teaspoonful of table-salt to a pint of water). This may be varied, if desired, by a solution of bicarbonate of soda (ʒij. ad Oj.) or sulphate of soda (ʒiv. ad Oj.), or a mixture of these salts may be used. If the secretion be hard, its removal is facilitated by spraying in first some liquid vaseline (paroleine), or by previously inserting, for a short time, plugs of wool lubricated with vaseline. To arrest the secretion astringents are sometimes recommended, but they are, as a rule, badly borne, and often endanger the sense of smell; on this account alum and zinc salts must be avoided. A spirit spray, beginning with 25 per cent of rectified spirit in water, may often be employed with advantage, also the smoking of the nascent fumes of chloride of ammonium from an inhaler. Local applications by the surgeon of a solution of nitrate of silver are sometimes of service. The insufflation of powders, though recommended by some authors, is, I think, best avoided. When erection of the turbinated bodies is a prominent symptom and does not subside under this treatment, it should be reduced by applications of the galvanic cautery. The most convenient plan is to score from behind forwards the anterior two-thirds of the inferior turbinated body under careful guidance of the eye. A fine cautery point is used, which is bent near the tip towards the side being operated on. Three or four of these linear cauterizations made at the same time one above the other are usually necessary. When the swelling affects the posterior end of the inferior turbinated bodies it is best, if possible, to remove it with a cold or hot snare introduced through the nasal cavity and guided, if necessary, into position with the finger in the naso-pharynx. After cautery operations on the nose, it is best to leave the parts entirely alone until the end of a week, when the slough may be removed with a pair of fine forceps. Electrolysis may be tried, but gives, according to my experience, less satisfactory results. In *hypertrophic rhinitis*, if the thickening is evidently producing obstruction, steps should be taken to reduce it. This is most satisfactorily accomplished either at the front or back with the cold or galvanic snare. The former, according to my experience, is preferable, and answers all purposes. Thickened portions that cannot be snared off may be burnt with the cautery or chromic acid. As in simple chronic catarrh, spurs, ridges, and deflections, which help to keep up the morbid condition, may have to be removed. Occasionally the turbinated bones, when narrowing the lumen, may have to be reduced by surgical means.

As regards *general treatment*, high dry climates are usually good for chronic nasal catarrh, and any condition favouring the recurrence of acute attacks is, of course, to be avoided. In gouty cases suitable constitutional treatment may also be adopted.

Coryza in Children.—The acute form affecting new-born children will be elsewhere described. Chronic coryza in older children is generally associated with adenoid vegetations and enlarged tonsils. There is usually no localised hypertrophy, but much general swelling, also often eczema of the vestibules. It frequently occurs with congenital syphilis.

Rhinitis caseosa is a name that has been applied to cases characterised by the accumulation of a white or faintly pink highly fœtid cheesy mass in one nostril, most of which it fills, giving rise to a sero-purulent secretion. Some authors, such as Klemperer, do not consider that it is a special form

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The nasal douche should never be used, on account of the risk of producing acute otitis media.

of rhinitis, but that the discharge, whether originating in the accessory sinuses or due to caries of the bone, etc. is simply retained and becomes decomposed. Others, like Cozzolino and M'Bride, are of opinion that it forms a separate disease.

The name *Rhinitis œdematosa* has been applied to an œdematous condition of the nasal mucous membrane (Mulhall), but it is not a generally accepted term. The last remark applies equally to *Rhinitis sicca*, in which there is diminished secretion.

Xanthosis of the nasal mucous membrane is a chronic condition described by Zuckerkandl, in which the mucous membrane assumes a yellowish dirty or rusty colour. It is chiefly found on the cartilaginous septum, but is occasionally seen in other parts of the nose. It will, therefore, be more properly described under diseases of the septum.

2. Atrophic Rhinitis, Fœtid (Ozæna) and Non-fœtid

This is a form of chronic rhinitis which is accompanied by wasting of the nasal mucous membrane and of the underlying bones. In the fœtid variety, also termed ozæna, the discharge forms tenacious masses and crusts which possess a highly penetrating disagreeable odour. In the non-fœtid form, which is much less common, the accumulation of secretion is not so marked.

Ætiology.—The ætiology of this complaint is very imperfectly understood. According to some authors, it is the result of atrophic changes in tissues which have been previously hypertrophied, but militating against this theory is the fact that most cases of ozæna date from early youth, although they do not usually come under treatment till puberty. It undoubtedly sometimes has its origin in acute infectious fevers. All authors agree that it is commoner in females than in males, this being the reverse of that found in hypertrophic rhinitis. Its occurrence in several members of the same family has often been noticed, but its unintentional transmission from one person to another is unsubstantiated.

Symptoms.—In some cases the external aspect is characterised by broad and depressed nasal bones, but this feature is not always noticeable. The three chief symptoms are: (1) Fœtor; (2) Atrophy; (3) Secretion. The fœtor varies in intensity in different cases and, as already mentioned, may occasionally be absent. The odour is attached to the inspissated secretion, as it is not noticeable after the removal of the latter. It is very characteristic, has been likened to that of decayed cheese, and is distinct from the odour met with in connection with necrosed bone or abscess of the accessory sinuses. The fœtor is not usually perceived by the patient himself. Nasal obstruction is often present, produced by the accumulation of discharge, and headaches may be complained of.

Rhinoscopic examination usually, but not always, shows the nasal cavities large, wide, and lined more or less with a yellow or greenish discharge which is frequently found dried up into scabs of greater or less thickness, presenting a gray surface resembling that of pumice-stone. They often fill the nasal cavities, and adhere tightly to the underlying mucous membrane. When these are removed by syringing or, if necessary, by forceps or wool mops, the underlying mucous membrane is usually found thin and wasted, and the turbinated bodies, especially the inferior, atrophied, making the nasal passages very wide, and allowing of a clear view of the naso-pharynx, often also of the anterior surface of the body of the sphenoid. The mucous membrane, especially that covering the turbinated bones, may be found red, uneven, and bleeding slightly. The nasal bones also undergo atrophic changes. In the same nose both atrophic and hypertrophic patches of mucous membrane are met with (Krieg), the former chiefly at the lower part. All these conditions generally affect both nasal cavities in a varying degree, but may be limited to one side. There is no ulceration of the mucous membrane in true ozæna. The diseased process often extends into the naso-pharynx, and may affect the pharynx (pharyngitis sicca) and even the larynx. Cases of ozæna affecting only the larynx and trachea have been described by Baginsky and Zarniko.

Pathological Anatomy.—Microscopical examination shows that there is first a round-celled infiltration of the mucous membrane, the round cells having a tendency to granular and fatty degeneration. Similar degenerative changes are found in the acinous and in Bowman's glands. On the margins of the bones are numerous Howship's lacunæ containing osteoclasts. The epithelium is generally converted into the cubical or pavement variety. of which the superficial layers may become horny. In later stages the cell infiltration gives place to a new formation of connective tissue, leading to shrinking of the mucous membrane and marked disparition of the glands and vessels (Zarniko).[1] E. Fränkel describes endarteritis obliterans, and Krause connective tissue thickening of the adventitia.

The true nature of this disease has been the subject of innumerable observations and theories. As regards the *fœtor*, as already noticed this arises only from the secretion, especially when it has lain for some time and hardened, for the fresh secretion has scarcely any odour. The smell is, according to some authors, simply the result of decomposition of the catarrhal secretion which stagnates in the nasal cavities on account of their abnormal width (Zaufal). Clinical observation, as well as physiological experiment, speak against this. B. Fränkel considers that suppuration of the atrophic mucosa is a necessary preliminary, but that for the production of the fœtor a ferment is required. Krause attributes importance to the alteration in the secretion by the presence of fat granules produced by the destruction of gland epithelium and of infiltration cells. These granules, mixed with the cornified epidermis, undergo rapid decomposition and give rise to the fœtor; but, on the other hand, this condition is not always present. E. Fränkel thinks that the absence of glands, especially Bowman's, enables the bacteria of decomposition to flourish. Volkmann and Schuchardt also attribute the fœtor to an anomaly of secretion which consists in the transformation of the normal cylindrical epithelium into a horny pavement epithelium; this decomposes and produces the smell in the same manner as occurs in plantar and axillary sweating, cholesteatoma, and intertrigo mammarum. This change is said to be always present in ozæna, but absent in non-fœtid atrophic rhinitis (Seifert). A special organism is, according to these authors, not required. On the other hand, E. Fränkel (1882) and Lœwenberg (1885) discovered the bacillus mucosus and declared it to be the cause of the fœtor. Hajek found bacilli resembling Friedländer's pneumo-bacilli.

The *atrophy* was considered by Zaufal to be a congenital defect, but this has been controverted by Zuckerkandl, who, in the examination of 252 young skulls, never found atrophy of the turbinated bones. Hopmann, however, upholds Zaufal's theory, and supports it by observations on the antero-posterior shortness of the septum in ozæna, which, in his opinion, cannot be owing to shrinking, but must be due to deficient growth. Zarniko and Bayer regard the disease as a tropho-neurosis of the nasal mucosa and the bony framework, from which the characteristic changes, metaplasia of the epithelium with cornification, superficial inflammation with formation of crusts, occur, and insist on the presence of a specific bacillus causing the fœtor. The majority of authors, however, appear to hold the opinion that the atrophy is the result of a chronic inflammatory suppurative process, and assume that the atrophy is preceded by hypertrophy.

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[1] *Die Krankheiten der Nase*, p. 189. Berlin, 1894.

In regard to the origin of the *secretion*, Michel first drew attention to the frequent implication of the accessory sinuses in ozæna, and maintained that the secretion always originated in one of these cavities. This has been controverted by—(1) the actual observation of the formation of secretion under the eye of the observer (Gottstein), and (2) by the post-mortem examination of cases of ozæna, in which the accessory sinuses were found healthy.

These observations are not accepted by Grünwald, who insists on the great rarity of general suppuration of the nasal mucous membrane in adults, and explains the symptoms of ozæna by the presence of *localized* suppurations. He does not, however, limit these to the accessory sinuses, but also locates them in narrow meatuses and even in the pharyngeal and faucal tonsils. He therefore regards ozæna as a symptom of different localised suppurations. Störk, on the other hand, regards ozæna as an infective disease, gonorrhœa or congenital syphilis, the latter occurring when the father is no longer suffering from active syphilis.

Finally, Strübing and Abel have, within the last few years, made extensive bacteriological investigations on the bacillus mucosus, which they have distinguished from Friedländer's pneumo-bacillus. They claim to have found it constantly present in the secretion of genuine ozæna, and, *per contra*, always absent in the normal nose and in all other diseases. They also found it disappear as a case was cured, and maintain that it is inoculable from nose to nose, and from nose to pharynx and larynx. They consider the fœtor as an inconstant symptom and the atrophy as not essential, the essential feature being the formation of a glairy, tenacious muco-purulent secretion. According to these authors, "ozæna is a peculiar inflammatory process with the formation of crusts, commencing usually in the nose, more rarely in the naso-pharynx, caused by the presence of a bacillus. Catarrhal appearances then develop, at first with hypertrophy, afterwards with atrophy. The latter occurs partly from pressure of the crusts, partly from inflammatory irritation by the poisonous products of the bacilli growing on the surface. The fœtor is a symptom due to mixed infection, is not originally in the secretion, but occurs easily from the bacilli of decomposition. The process can creep into all the accessory cavities, as well as into the naso-pharynx, larynx, trachea, and the tubes, but it is not identical with accessory sinus suppuration. It may at the commencement remain for a long time without extending; when the process is fully developed in the nose the larynx is also generally affected with swelling or atrophy, redness, and formation of crusts. Loss of voice, amounting even to aphonia, dyspnœa, and cough may result from these crusts, which have a predilection for the subglottic space and the region below the anterior commissure. There is generally pharyngitis sicca. Dyscrasiæ are not necessary, although they may predispose to the disease; quite healthy individuals may be affected."

None of these theories have yet met with general acceptance.

Diagnosis.—Apart from foreign bodies, ulcers, and diseased bone, which are detected without difficulty by rhinoscopic examination, the point of chief importance is to distinguish the disease from empyema of the accessory sinuses, especially of the maxillary antrum.

Prognosis.—*A priori* it would seem impossible in advanced cases to restore the wasted glands, ciliated epithelium, and vessels of the atrophic mucous membrane, and that therefore ozæna is incurable seems to be the experience of most observers. It is, however, a condition that, as long as it is confined to the nose, may with suitable treatment be made quite bearable, and deprived of its objectionable features. In the earlier stages a cure is more feasible, and in advanced age the disease is said to undergo spontaneous recovery.

Treatment.—The treatment involves in the first place a thorough cleansing of the nasal cavities of crusts and discharge. This is accomplished by the use of a Higginson's syringe (see above, p. 389), with a normal solution of common salt or a weak alkaline solution, to which a few drops of liq. pot. permang. may be added. Previous loosening of the crusts by the insertion of plugs of wool moistened with vaseline, or the use of a paroleine spray may be required (see above, p. 389). The crusts may at first have to be removed by the surgeon with forceps. Various antiseptics are then sprayed into the nose, such as a solution of hyd. perchlor. (strength 1 to 5000–1 to 2000). A saturated solution of acid. boracic, or a 10 or 20 per cent solution of menthol in paroleine, or other mild antiseptic, may be substituted. By this treatment, carefully carried out by the patient twice, or, if necessary, three times a day, the formation of crusts and the occurrence of fœtor can be kept in abeyance, and gradual improvement may in course of time result; but the patient must be particularly informed that he will have to continue the treatment regularly, probably for years, in order to keep himself in a state of comfort. It is important for the surgeon to see that the patient thoroughly understands the cleansing. An occasional application by the surgeon of a solution of argenti nit. (grs. 10-60 ad ℥j.) on a wool mop to the whole of the interior of the nose seems to be of benefit. Other remedies have been recommended. Listerine is used as a spray by Lefferts, and syringing with a solution of aceto-tartarate of aluminium (a small teaspoonful of a 50 per cent solution in a pint of water) is recommended by M'Bride and Schäffer. Gottstein's method, which has not found much acceptance in this country, consists in inserting a large cotton-wool plug into one nasal cavity, leaving it in for twenty-four hours, and then, after an interval of the same time, using a similar plug on the opposite side. Gottstein kept the plugs in at night, but other authors have modified the treatment by retaining the plugs (which must be firm and cigar-shaped) for a few hours during the daytime in each nostril.

Vibratory massage of the turbinated bodies, light touching with the galvanic cautery, and applications of the constant current, have also their advocates, but I am not aware that they possess any special advantages. A method of treatment which has found several adherents is that of cupric-electrolysis. It was originally recommended by Jouslin and Cheval, and has been advocated by M'Bride and others. After thorough cocanisation of the nasal cavities, and removal of all crusts, a copper needle attached to the positive pole is inserted into the inferior or middle turbinated body, while a platinum or steel needle connected with the negative pole is plunged into the septum. A current of from 3-10 milliampères is employed for about ten minutes. The operation is, if necessary, repeated more than once on each side at intervals of a fortnight. When the naso-pharynx is affected it requires, in addition to the cleansing, special applications made with a brush or spray. The anæmia which often accompanies ozæna must also receive attention.

6. Chronic Infective Diseases of the Nose

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Syphilis.—The nose may be attacked by syphilis in any stage of the disease. The primary chancre has been met with on the nasal mucosa; in such an unfortunate infection of rare occurrence the diagnosis would have to be made from a sarcoma. Under antisyphilitic treatment the chancre disappears, leaving a slight scar. In the secondary stage a general nasal catarrh may occur, often slight and liable to be overlooked. The lesions more commonly observed, and causing greatest destruction, are those met with in the tertiary stage, and must be grouped amongst the later manifestations of this stage. They may be the result of infection or the outcome of a hereditary taint.

The septum and the floor of the nose are the parts firstly and mainly affected. It is highly important that the gummy tumour which precedes the ulceration should not be overlooked; by its early detection and by antisyphilitic treatment being vigorously pushed, a considerable amount of destruction may be averted. A gumma usually develops on the septum and near the floor of the nose, and may be situated far back. It is therefore necessary in a suspected case, when an examination of the anterior nares gives a negative result, to thoroughly investigate the posterior nares by rhinoscopy.

A small gumma not uncommonly occurs in the region of the raphe on the roof of the mouth, which, on breaking down, may involve the floor of the nose, or it may be due to extension of the disease from the nose. By careful examination with a fine, flexible, and blunt-pointed probe a minute opening, at first not visible to the eye, may be found leading up to the floor of the septum, and in this way bare bone may be opportunely detected. An examination made in this way, through the mouth, has enabled the writer to detect syphilitic disease of the nose at a time when the objective evidence in the nose itself was not sufficient to permit of a definite conclusion being arrived at, and at a time when the greatest amount of benefit could be gained by treatment.

When syphilis attacks the septum ulceration and perforation, as is well known, is of common occurrence, and can be distinguished, it is said, from that of a simple nature by the bone being involved. By extension of the morbid process the turbinated bodies may be destroyed and the accessory sinuses opened up.

As the result of the contraction of the connective tissue, subsequent to the destruction of the nasal bones, the condition of so-called "saddle-back" nose appears, but it is the opinion of some—which opinion is shared by the writer—that this appearance may be occasioned by causes other than syphilis.

Syphilis may attack and be localised in the naso-pharynx, which further emphasises the importance of posterior rhinoscopy in these cases A tertiary lesion localised in the naso-pharynx may lead to dangerous hæmorrhage. Cases have been recorded in which, after the loss of a necrotic part of a cervical vertebra, fatal hæmorrhage has occurred from the carotid and vertebral arteries.

Mention must also be made of the inherited variety in infants, characterised by a catarrhal condition of the nasal mucosa, giving rise to snuffles, and seriously interfering with respiration and feeding.

The diagnosis of nasal syphilis, as a rule, is not difficult. Chronic glanders, with which it may be confused, is a rare disease, and tuberculosis does not occasion so much destruction, moreover, a bacterioscopic examination will generally eliminate any error in diagnosis. Lupus, in a certain group of cases, it is difficult to exclude, excepting by a course of antisyphilitic treatment.

The treatment of the nasal condition is essentially that of the disease itself, and, as has already been mentioned, the remedies must be vigorously pushed. It is as well to give iodides in conjunction with mercurial treatment. The parts should be kept cleansed with antiseptic douches; and in infants, in order to keep the meatuses free, the passage of a soft tube may become necessary.

In the tertiary lesions the separation of the resulting sequestra may be tedious and difficult, and it has been suggested that this may be overcome by boring the bone and loosening it with a hook, separation in this way being more readily obtained. The discomfort occasioned by a perforation through the roof of the mouth may be met with a plug, at first of soft material, such as cotton wool, and after cicatricial contraction has taken place, with an artificial plate; if after withdrawal of antispecific treatment no relapse takes place, operative closure of the perforation may be attempted.

Tuberculosis.—The number of cases of tuberculosis of the mucous membrane of the nose that have been so far recorded is very small. Primary infection may be set up with the finger, chronic catarrh and crusts contributing to form a suitable nidus; but nasal tuberculosis is usually associated with the disease in the lungs or other organs. It ultimately presents itself in the form of ulcer or tumour, the two often co-existing. The cartilaginous portion of the septum is the more usual seat of the disease, but it may also occur on the turbinate bodies. The tumour may be of sufficient size to completely block the nostril. When an ulcer forms on the septum it is commonly indefinitely circular, of a grayish colour, and perhaps perforating, hæmorrhage readily taking place when an examination is made.

The symptoms, as already mentioned, are mainly a tendency to hæmorrhage, nasal obstruction, and an increase of nasal secretion, which may become offensive, but pain is rarely present.

The diagnosis has to be made from lupus, syphilis, glanders, and in children from chronic eczema. From lupus it can be clinically disassociated by the absence of the characteristic growths in the skin. Lupus may extend to the mucous surface of the nose, and a differential diagnosis then becomes difficult. A bacterioscopic examination will enable one to distinguish the ulceration from that occasioned by syphilis, glanders, and eczema.

The tuberculous tumours may have to be differentiated from other tumours, such as sarcoma and fibroma, and it is important that the section made for this purpose should be cut through the deepest parts of the growth.

Tuberculous disease of the nose does not materially affect the prognosis of the general or pulmonary disease of which it is a part, in the way that tuberculous disease of the larynx adds to the gravity of a case.

The treatment must be general and the same as that adopted when tuberculosis affects other regions. The special treatment to be directed to the local lesion consists in removing the growth, curetting the ulcers, and treating them with lactic acid, after the method suggested by Krause in the treatment of tuberculosis of the larynx. Relapses occur, but it will probably be found, with increasing experience, that by means of tuberculin the disease can be made more amenable to treatment.

Lupus.—Lupus has many points pathologically in common with tubercle, and it is often with difficulty that it can be clinically distinguished. Lupus is very seldom primary in the nose; in a large majority of cases it is an extension from the integument adjacent to the anterior nares; the septum is commonly attacked early. On inspection the meatuses are usually found to be more or less obstructed by crusts; it is only after the removal of these the nature and extent of the disease can be made out. The nasal mucous membrane can then be seen studded with small nodules, usually discrete, at times ulcerating and coalescing. The diagnosis has to be made from syphilis—the latter runs a more rapid and destructive course, and responds to an antisyphilitic treatment. The disease may be associated with syphilis, and at times it is difficult to distinguish the two.

Lupus runs a chronic course, and the treatment, as in the case of tuberculosis of the nose, must be general as well as local. Locally the nodules may be removed by means of galvano-cautery, curetted and treated with lactic acid. Tuberculin may certainly be tried, for some of the patients treated with it have been permanently benefited.

Glanders.—This disease is occasionally met with affecting the nose in a chronic or an acute form. In some cases of glanders the nasal mucous membrane is secondarily infected, and thence inflammatory swellings may spread to the tissues of the face. Symptoms of rapid pyæmia supervene, and death commonly ensues in the course of two or three weeks. In the chronic form the disease may last for months, and recovery then occur; but it usually takes on the characters of the acute form with a rapidly fatal result.

Any doubts about the diagnosis can be set at rest by microscopic examination revealing the presence of the glanders bacillus discovered by Löffler and Schutz in 1882. An absolute diagnosis can only be made by means of cultures and animal experiments.

Leprosy.—Leprosy attacks the mucous membrane of the nose, and is characterised by ulceration and destruction of the bony parts. A diagnosis can be arrived at by means of a bacterioscopic examination, treatment can only be symptomatic, and directed towards the removal of the crusts and cleansing of the parts.

Rhinoscleroma.—Rhinoscleroma is a very rare disease, and is scarcely ever met with in this country. The majority of cases that have been reported have been in the south-east of Europe; a few in Central America, Egypt, and India.

The disease belongs to the group of infective granulomata, and is characterised by nodular thickenings in the mucous membrane of the nose and the adjacent skin. They also occur in the pharynx, larynx, and the upper part of the trachea. In the nose it is prone to attack the cartilaginous part, and the commencement of the bony part of the nasal cavity and choanae.

The symptoms to which the disease gives rise are, in addition to a certain amount of deformity, a feeling of stiffness and discomfort about the integument occasioned by the infiltration of the tissues. The nodules show no tendency to break down or to ulcerate. The disease is slowly progressive, and the obstruction which it causes may require operative treatment.

The morbid process is occasioned by a bacillus, first described by Frisch. The cells in the granulation tissue forming the nodules have peculiar characteristics, and present an appearance of degeneration. The bacilli lie within these cells, but they have been observed lying free in the lymphatic spaces around. They are short, oval rods with capsules, and closely resemble Friedlander's pneumo-bacillus; they do not stain by Gram's method. Another organism has been described, but experimental inoculation has done but little to dispel the doubts that have arisen on the subject.

Rhinoscleroma is a slow, progressive disease, and treatment has not demonstrated its curability. Inunctions of lanolin containing one per cent of corrosive sublimate have been recommended and attended with some success. Resolution and disappearance of the condition has been recorded after an attack of typhus fever.

The obstruction in the nostrils can be overcome by mechanical and surgical measures.

Henpuye.—The peculiar nature of this disease, and the fact that very little was known as to its nature, led Dr. Albert J. Chalmers to make the inquiries which were embodied in a report,[1] and it is upon this report that the following account is based:—

Henpuye, or dog-nose, is a disease frequently met with in the Gold Coast Colony, and in certain portions of its hinterland. The hideous deformity of the face which it causes is very striking to anyone who has lived in this part of West Africa. It is also known on the French Ivory Coast under the name of "goundu" or "anakhre," but "henpuye" is the native name (Appolonian) for the disease on the Gold Coast.

Henpuye starts in a native of West Africa during, or soon after an attack of yaws, in which there is a history of the nasal mucous membrane being attacked, as a small bony swelling symmetrically placed on either side of the nose. This swelling, which is generally oval, with the long axis directed downwards and outwards, is attached to the nasal bones, the nasal process of the superior maxilla, and also to the superior maxilla in the more advanced cases. It is produced by the deposition of new bone under the periosteum on the external aspect of these bones, and grows slowly in all directions. It in no way affects the mouth or the orbital or nasal cavities in any case which the author has seen, and the nasal ducts are quite unaffected. Rarely the growth is asymmetrical, being situated only on one side of the nose. Pain in the nose, with the presence of a sore in that organ, are the symptoms complained of at the commencement of the disease; later, headache is sometimes felt, and pain in the swelling during wet weather. As the growth becomes larger it seriously interferes with the sight by growing up in front of the eyes, and even hiding them, but it has not been seen to cause destruction of the eyeball. The growths may remain quite small, or may grow to be large lumps. No case has been reported in which they break down or ulcerate.

As regards the morbid anatomy, the periosteum strips off readily, and under this is a thin shell of compact bone which appears somewhat rigid on the side toward the periosteum. The rest of the tumour consists of cancellous bone. The whole swelling cuts readily with bone-forceps, and consists of quite soft bone. On making microscopical preparations of the growths there were signs of ossification in membrane proceeding under the periosteum, and the rest appeared like ordinary wide-meshed cancellous bone. The whole process appeared to be that of a slow "osteoplastic periostitis."

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[1] Report on "Henpuye" in the Gold Coast Colony, *Lancet*, January 6th, 1900. Albert J. Chalmers.

Two views on the etiology of this disease have been brought forward up to the present time, viz. (1) that the swellings are of a racial character, and (2) that the process is started by the larva of some insect. With regard to the first, the disease is found in Ashantis, Grunshis, Fantees, Ahantas, the Ga people, etc., races quite different from one another, so that this view cannot be entertained. As to the second, there is no evidence which would support the idea that the disease was started by a larva. On the other hand, there is always the history of yaws, and of the tumour starting during the attack of yaws, *i.e.* during the period of eruption, or soon after. Then, again, the patients complain of pain in the nose, with in some cases distinct history of a sore, and sometimes discharge preceding the swelling. This might be due to some irritation or ulceration of the nasal mucous membrane by the yaws.

LITERATURE OF HENPUYE.—Professor ALEXANDER MACALISTER. *Royal Irish Academy*, 1882.—Surgeon J. J. LAMPREY, A.M.S. *British Medical Journal*, vol. ii. 1887.—Dr. HENRY STRACHAN. *British Medical Journal*, vol. i. 1894.—Dr. MACLAUD. *Archives de médecine Navale*, 1895.

7. Post-Nasal Adenoid Growths

POST-NASAL GROWTHS—
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Sufficient time has elapsed since Meyer of Copenhagen in 1868 first described[1] the clinical importance of post-nasal obstruction to enable us to estimate the true importance of the subject. During a period of twenty years, which represents the history of the subject in this country, the profession, sceptical in the first place, thanks to the exaggerations of the specialist, has grown of late over-enthusiastic for the removal of the so-called adenoid growths of the post-nasal space; while the general public have become so desirous that the benefit they see from these operations should be extended to all children alike, that they are often disappointed when assured that no operation is required in this or that individual case.

The operation for the removal of adenoids is so universally advocated now in suitable cases that it is the most frequent of all operations, and in another twenty-five years, it is to be hoped, every general practitioner in the country will consider its skilful performance as one of the first requirements in the family-doctor, and yet will not fall into the present danger of considering that every child would be the better for the operation. Indeed, owing to such excess of zeal, we already see indications of the falling into disrepute of a procedure which is probably doing much in raising the general standard of health in the population.

Accumulated experience has added but little to our knowledge of the ætiology of the disease. We are all persuaded now that it is no new development or vicious manifestation of a degenerate age. Nevertheless, the affection is more commonly observed in those individuals who have the V-shaped alveolar arch with its modifications. This narrow upper jaw is associated, according to the degree of elevation of the hard palate, with encroachment on the nasal fossæ in the form of deviations and thickenings of the septum. No doubt such contraction of the superior maxilla, together with the short upper lip, is an undesirable variation due to civilisation; for such variations from the strictly normal type are not encountered among aboriginal races, nor are they so frequently found among the lower orders as among the highly educated and luxurious. Yet adenoids are by no means confined to individuals presenting such peculiarities, though I suspect that the hypertrophy is invariably found in children presenting the narrow upper jaw. We have doubtless predisposing factors, which may be either inherited or acquired, apart from the narrow upper jaw which is emphatically an inheritable feature; among such is what used to be called the strumous diathesis. Precisely the relation which adenoids bear to a tuberculous predisposition has not been determined, although such a relation would appear to exist, when we remember that enlarged cervical glands are almost invariably present in cases of adenoids, and that the point at which we are to determine whether such glandular enlargements are to be considered as tuberculous or merely as a sympathetic hypertrophy is impossible of clinical definition. Still there can be no doubt whatever that hypertrophy both of the post-nasal lymphoid tissue and of the cervical glands not infrequently precedes the infection of the hypertrophied tissue with the tubercle. Nor must we forget the recent tendency to consider the post-nasal adenoids as a definite nidus in which the tubercle bacilli find a resting-place and fertile soil for their cultivation (Sims Woodhead).[1]

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[1] *Trans. Med. Chir. Soc.*, 1870, vol. lviii. p. 191.

Yet in spite of such predisposing factors most cases are developed as the result of acquired proclivities. Some babies are no doubt born with adenoids, at any rate if we may so judge from the fact that often where we find the growths gravely obstructing the breathing in infants, we are told that the little patient has snored since birth; and this in cases where there is no definite evidence of either of the predisposing factors mentioned: indeed, so far as the contracted superior maxilla is concerned, we are compelled to admit that this is never observed in infancy. Congenital syphilis is supposed in certain quarters to be a very important factor; if this is so we must admit that it is extraordinarily rare to find in the subjects of adenoids other evidence of the contamination. Yet I have myself observed a particular virulence in the growths and their tendency to recurrence in children where I have known the father to be syphilitic, and although his children were supposed to have escaped altogether the congenital disease.

Among the more immediate causes stand influenza, measles, and whooping-cough as more often originating adenoids than the other acute exanthemata. The increasing prevalence of these three diseases of late years is doubtless the main reason why adenoid operations have become increasingly imperative; and the general practitioner, who is the most competent to judge upon such a point, and whose eyes have been pretty generally alive to the clinical facts of adenoids for ten years at least, generally maintains the increasing prevalence of buccal respiration and snoring together with the liability to contract colds upon the slightest provocation. This tendency to cold-taking often appears to be an important factor; although, seeing that this is altogether the commonest symptom induced by the growths, it is difficult to separate cause from effect.

But whatever view we may favour as to the probable cause of adenoids, whether local or constitutional, we must ever bear in mind that, so far as the pathologists have at present informed us, it is impossible to determine at what precise point of enlargement this lymphoid tissue which underlies so thickly the mucous membrane of the post-nasal wall is to be considered as pathological. It may even become a question as to whether the growths in themselves can be pronounced as morbid, and whether they have any importance beyond the mechanical obstruction. Such, at any rate, is the present tendency of belief, although some observers appear to consider the adenoids as a direct invitation to the contraction of catarrhs in general, whether nasal, bronchial, or gastric. My own inclination is to regard the common symptom of excessive cold-taking as due to the obstruction, seeing that we find the same tendency in every form of nasal stenosis, whether polypus, enlarged inferior turbinals, or mere deviations of the septum. And we may state that it is the restoration of the normal conditions of ventilation which is responsible for the cure of the tendency to take cold in all cases of nasal obstruction. Possibly the actual overheating of the nasal fossæ, when deprived of the cooling, inspired air-current, may cause hypertrophy of the lymphoid tissue; for recent experiments on the physiology of the nose indicate that the amount of heat taken up from the mucous membrane is enormous.[1] Indeed, roughly speaking, it may be asserted that however cold the external atmosphere, the inspired current of air is raised to the temperature of the blood before reaching the pharynx. That overheating causes overgrowth of the lymphoid tissue is a more likely explanation, when we remember that nasal catarrh in one form or other generally precedes the first development of symptoms of adenoids. It is, moreover, by no means uncommon to find some other form of nasal stenosis in the anterior nares, such as vascular engorgement of the inferior turbinals, or in other children, malformations of the septum. Further, it is possible that where there has been anterior obstruction antecedent to the development of the adenoids, the abnormally low inspiratory pressure behind the point of narrowing, which is necessary in order that the pressure in front may be sufficient to force the air-current through the constricted channel, accounts for an overfilling of the capillaries of the mucous membrane lining the partial vacuum, and thus for hypernutrition of the lymphoid tissue. For, as I shall presently show, even when there is a grave degree of nasal obstruction, patients, and more especially very young children, possess the instinct of nose-breathing as distinguished from buccal so strongly that they persist in its practice in spite of the great effort necessitated, and in spite even of insufficiency in the oxygen-supply.

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[1] *Lancet*, 1894, vol. ii. p. 957.

So much for the ætiology of the affection. When we arrive at a consideration of the symptoms we are surprised, considering their definite nature, and the fact that the whole parental public is now acquainted with the more important among them, that it is necessary to devote so much space to their discussion. Yet although they are so definite and suggestive, there is not one that can be altogether relied upon in diagnosis; indeed, even an objective examination, whether by post-rhinal inspection or by palpation, cannot altogether be trusted in determining the necessity for operation, as will presently be explained. Briefly we may assert, that although for an accurate diagnosis objective examination may be essential, it is nevertheless equally important, in deciding whether necessity exist for operative interference, that we do not rely so much upon such examination as upon the symptoms. And this somewhat paradoxical claim will be immediately substantiated.

The symptom to which the imperfectly informed mostly trust in determining the presence of adenoids is doubtless buccal respiration. Yet it must be remembered that this is altogether an acquired habit, and is not usually found in infants; while not infrequently children as old as four years still, during waking as well as sleep, adopt nose-breathing, in spite of grave degree of posterior or anterior nasal stenosis. Indeed, the custom is with nearly all children, and not infrequently with adults, to adopt nose-breathing chiefly, often entirely, during sleep in spite of the impossibility of sustaining free respiration through the nostrils.[1] And we must be careful not to assume that because the lower jaw is dropped, or the lips widely open, that the patient is therefore breathing through the mouth. In young infants this is strikingly not the case, as can easily be verified by placing a morsel of down in front alternately of mouth and nostrils. Many children, after the removal of all obstruction, still carry the lips apart and the jaw dropped; yet it will be found that, during sleep at any rate, they are breathing entirely through the nose. The determination of the point while a child is awake is obviously more difficult. And even before operation, and while the child is snoring loudly, it will be generally found that respiration is not conducted, as would appear, through the mouth. One could hardly understand, if these children habitually breathed through the mouth, why they should suffer from such definite proofs of insufficient aeration. A frequent observation among the parents of these cases is that they recover from their anæmia and tendency to cold-taking whenever they are at the sea-side, but that they immediately lose all they have gained from the freer supply of air in such localities on returning to town life, and immediately begin their old habits of taking cold upon the least provocation. The only possible explanation lies in the supposition that, in spite of buccal respiration, they fail to obtain a free supply of air. Consequently, we shall not be much surprised at learning that very young children, more especially under two years of age, who have not yet learned to supplement the obstructed nasal respiration with buccal breathing, frequently keep the mouth habitually closed in spite of very grave post-nasal obstruction. And consequently, once more, we shall not be surprised to discover that the younger the patient the greater the gravity of the symptoms for a given degree of nasal stenosis. In older children, who have learned the advantage of mouth-breathing, we more often find grave degrees of nasal obstruction without there being any material evidence of defective nutrition; while I am tolerably convinced, for reasons to which I shall refer again, that in older children the mischief to the general nutrition may be less in cases where the obstruction is sufficient to enforce the entire adoption of mouth-breathing. From a consideration of such facts the absurdity will at once be apparent of the argument adduced in quarters where one would have looked for more wisdom, that if only children were compelled to breathe through the nose their adenoids would spontaneously disappear! I can conceive of no greater ignorance than to use any moral or mechanical persuasion to compel children to nose-breathing, seeing that the instinct to adopt it is paramount, provided a sufficient supply of air can be secured. Better must it be for them to breathe through the mouth, and thus breathe easily, in spite of the dangers resulting from perpetual irritation of their larynx and bronchial and Eustachian tubes, than to deprive the tissues of sufficient nutriment.

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[1] *Vide* author's, *On the Respiratory Functions of the Nose*, 1889, p. 25.

The most striking consequence of this breathing through a narrowed nose is the malformation of the thoracic walls so commonly observed in these patients. Formerly they were all attributed to rickets, although enlarged tonsils were assumed, before the discovery of adenoids, to have some part in the faulty expansion of the chest-walls. Pigeon-breast is always acquired, and is essentially mechanical. If we admit that nasal respiration is still practised in spite of grave stenosis of the nose-passages, it follows inevitably that the difference between the intra-thoracic atmospheric pressure during inspiration and the external pressure must be greater than obtains where the access to the thorax is not obstructed, and that consequently the external atmospheric pressure weighing upon the chest-walls will lead to their collapse in greater or less degree. This is observed in the most characteristic manner at the anterior aspect of the lower ribs and costal cartilages, which present an appearance of flattening or actual concaving of the surface. Nor do I think that it is ever observed in cases where there is no nasal obstruction, although it is doubtless more conspicuous where there is rickets. On the other hand, we sometimes see in cases of adenoids a depression of the sternum in various degrees; but I am convinced that this is seen sometimes where it cannot be supposed that the stenosis is sufficient to account for it. But an appreciation of the lateral collapse of the walls, I maintain, is of the utmost importance as an objective indication of the degree to which the patient has actually suffered from the adenoids; for it is evidence of the degree of imperfection in the supply of air. And, given the fact of the existence of adenoids, I consider an examination of the thorax of greater moment in determining the need for operation than even a digital palpation of the post-nasal space, seeing that even when the amount of adenoids is enormous some patients may habitually adopt mouth-breathing, and thus escape the penalty of defective air-supply. In such case operation may not be so imperative from the point of view of general health, although the local harm may be correspondingly more serious.

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[1] *Vide Post-nasal Growths.* By C. A. Parker, 1894, p. 35.

Snoring is another symptom upon which the laity chiefly rely for diagnosis, and not infrequently it is argued that when this indication is absent there can be no adenoid growths. But the symptom is no more to be relied upon than buccal respiration, although I am prepared to affirm that snoring is never pronounced in children without there being nasal stenosis of one form or other to account for it.

The remaining symptom of common occurrence in adenoids is the great tendency to contract colds, whether in the nose, throat, bronchial tubes, or, according to Dr. Eustace Smith, in the stomach. And as the irritation of the bronchial tubes sometimes results from nasal obstruction, whether as a direct consequence of the buccal respiration, or whether in some more subtle manner with which we are not fully acquainted, we shall not be surprised to learn that asthma must be reckoned among the symptoms of adenoids, nor to learn that the trouble not infrequently disappears entirely after operation.

Various other nervous symptoms are often attributable to nasal obstruction in children, the commonest among which is laryngismus stridulus. Dr. Eustace Smith[1] has recently assured us that the malady in infants is invariably caused by adenoids; and although my experience of the general affections of childhood is too limited to allow me to corroborate such distinguished opinion, I am yet able to affirm that I have never removed adenoids in an infant with the direct object of curing laryngismus without doing so; and that in the most unequivocal manner. Correspondingly general convulsions, if not epilepsy, are occasionally, though rarely, caused by adenoids and cured by operation. Chorea, nocturnal incontinence of urine, nightmare, sleep-walking, are also not seldom cured by the removal of nasal obstructions. Yet I think all such affections must be considered as the consequence of the nasal obstruction rather than of adenoids in particular, for the results of operative treatment are quite as striking in many cases of nasal obstruction in adults, although perhaps the improvement in general health is not quite so rapidly observed.

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[1] "Adenoid Growths in Children," *Lancet*, May 25th, 1895.

The German and American schools have made much of the symptom now commonly known as *aprosexia* (from ἀ priv. and *προσέχειν*, to attend (Guye)). By the term is signified a definite lack of the faculty of application to their studies in the little patients, although it does not indicate any actual lack of mental ability. I am not persuaded that this is in any way different from what we find in any child in whom the general health has undergone deterioration; but there can be no question that after operation these children improve remarkably in the ease with which they learn, *pari passû*, indeed, with the improvement in general nutrition.

The prognosis in these cases could hardly be more satisfactory, except perhaps for the patients who have attained adult life, and in whom the mischief wrought by the long-continued obstruction has become irremediable. Yet even in patients advanced to middle life, one is justified in holding out hope of definite improvement, especially if the main complaint is either deafness due to Eustachian catarrh, or a habit of constant cold-taking. Nevertheless, generally speaking, one lays it down as a prognostic rule that the older the patient beyond sixteen years, the more guarded should be the prognosis, although, whatever the patient's age, we are justified, provided the symptoms are definitely associated with nasal obstruction, in urging operation. In defining a prognosis, however, care must be taken, where the main consideration is the deafness, not to assume that, because the patient is deaf and there is a mass of adenoids, the former must be caused by the latter. Labyrinthine deafness is by no means rare in children with and without adenoids, and there should be no difficulty in determining the precise nature of the deafness from inspection of the membranes before giving a prognosis. In the neuroses also, whether asthma, laryngismus, chorea, or convulsions, the prognosis must be guarded, although in bad degrees of obstruction we may be hopeful of securing remarkable results.

The treatment resolves itself into the question of operation and a brief inquiry as to the value of local remedies. To answer the latter first, I may affirm, after a somewhat extended trial of astringents, that they are absolutely useless, except in the case of very recent and rapid developments of the obstruction, such as one sometimes sees after measles, whooping-cough, etc. In such instances we must, I think, assume that we are dealing with a condition comparable to a sub-acute tonsillitis, and may expect as much good from the application of astringents as in the latter case. But the astringent employed must be weak, and there is nothing better than glycerine of tannic acid, fifteen or twenty drops to the ounce of water. It should be injected along the inferior meatus, care being taken that it is not directed into the middle passage, which is curiously intolerant of all applications of an astringent nature. But where the history of the symptoms justifies the supposition that the disease has been in existence for over a twelvemonth, I do not think that the treatment is of any use; while in very small patients the local applications may cause so much distress that an operation is an altogether less formidable proceeding. And indeed the operation skilfully performed is so simple a matter, causes so little discomfort, and invites such infinitesimally small risks, that one is justified in thinking that in any case of doubt as to whether or no an operation is necessary, he ought to decide in its favour.

The safety of the operation mainly depends upon the administration of the anæsthetic; and much argument has been used as to the relative merits of chloroform, gas, ether, and of their various admixtures. Nitrous oxide is in high favour at the present moment in certain quarters; and in adults, where there is no tendency to recurrence of the growths and perfect removal is less essential, I often employ it. And in the newer methods of continuous administration, or of combining it with oxygen, the operator may, by a clever anæsthetist, be afforded all the time that he requires. But the objection to its general use lies in this fact that the degree of anæsthesia is too profound, the pharyngeal and laryngeal reflexes annulled, and that consequently the risks of blood, and still more of portions of the growth, especially when the curette is used, finding their way into the glottis, are considerably increased. To ether the same and other objections apply, viz. that it is necessary to operate with a deeper degree of anæsthesia than is desirable, while the bleeding is undoubtedly, as also with gas, greater than with chloroform, and the subsequent misery is far in excess of that due to either chloroform or its admixtures. Consequently I consider that chloroform, either alone or mixed with ether or alcohol, or both, according to the fancy and experience of the administrator, is altogether the most perfect anæsthetic for adenoid operations: (i.) because of the superficial degree of anæsthesia of which it permits, (ii.) because of the less hæmorrhage, and (iii.) because of the minimum subsequent misery.

If chloroform be the anæsthetic chosen, the patient must lie flat on a table, the head being neither raised nor lowered, though it was the general custom a few years ago to allow the head to hang over the back of the table, as if to lessen the risk of the blood entering the larynx. But the objection to the latter position lies in the increased venous engorgement and consequent hæmorrhage, not to mention the danger of blood entering the Eustachian tubes and exciting a suppurative otitis media. On the contrary, if the patient is lying flat on a table he can be turned on the side in a moment, and the blood allowed to flow from the mouth and nose; while, should the hæmorrhage be profuse, the operation can be completed on the side.

Usually it is necessary to cut one or both tonsils at the same time, the practice of making a separate operation of tonsillotomy having no plausible excuse. The gag should be held at first in the right side of the mouth by the anæsthetist, and the left tonsil removed with a spade tonsillotome; the gag is then reversed and the other tonsil removed. There is good reason for preferring a relatively blunt instrument, partly because the hæmorrhage is less when the amount of pressure used to thrust the blade through the tissues is greater, and partly because it holds the severed structure more securely. Next the surgeon, still standing on the right side of the patient, thrusts the forefinger of the left hand into the post-nasal space with the palm upwards, followed by the forceps or curette, as the case may be, held in the right. If the forceps are used, and they have the advantage of bringing the growths away, instead of merely sweeping them into the pharynx, and thus lessen the risk of their slipping into the larynx, they are directed to each piece of the growth before it is pulled out, and should never be allowed to seize anything unless so felt with the finger. This provision is the more important seeing that it is by no means an unknown accident for a portion of the Eustachian tube, or a splinter of the vomer, to be torn out. And it is quite conceivable that some of the untoward events of which one has heard now and again have been due to such rough handling of what may be a very mischievous instrument. So that, in spite of the superiority of the forceps, I consider that in the hands of one inexpert the curette is the safer instrument. Having removed all the larger portions with forceps, and detached them from the instrument by dipping it into some antiseptic solution, care moreover being taken not to overlook the presence of the growths in Rosenmüller's fossæ behind the Eustachian tubes, as well as remembering the possibility of thrusting large pendulous growths before the finger or instrument into the posterior choanæ and thus allowing them to escape removal, the posterior wall of the post-nasal cavity may be smoothed down with the curette as a final procedure. Yet even after the use of this, it is well to examine the whole region very carefully with the finger to ascertain that the removal has been completed satisfactorily.

The whole operation should not take more than two or three minutes, and is frequently done in less, even where tonsils have to be cut, and the mass of growth is enormous. The main difficulty and anxiety is the hæmorrhage; one may state that but as a rule the amount of blood lost lies in direct proportion to the length of time occupied, and that the bleeding never ceases until the operation is finished. And so rarely need anxiety be felt on this score, that one is perhaps apt to forget the possibility of having to adopt any measures for the mitigation of the bleeding. Occasionally it proves necessary to turn the patient on the side before the operation is completed, and even to finish it in that position, and now and again one likes to sponge the patient's forehead with ice-water, or drop small portions of ice into the nostrils, so that they may find their way into the post-nasal space. This is probably more effectual than allowing the patient to suck ice, as the act depends upon exhausting the air from the buccal cavity, which in its turn would probably favour the flow of blood from the open vessels. But out of over five thousand cases of adenoids upon which I have operated, I have never once had to plug the post-nasal space for hæmorrhage, though on one or two occasions I have feared it might become necessary. When the tonsils bleed more than I like I apply a styptic paste which I have found very efficacious. It consists of equal parts of tannic and gallic acids and powdered matico leaves, worked into the consistence of a pill-mass with glycerine. A piece of this paste, the size of a filbert or less, can readily be held in the two first fingers of either hand, and rubbed into the bleeding tonsil. In no other way can an astringent be properly applied, the painting or rubbing on with brush or pledget of cotton-wool of a solution of perchloride of iron being altogether futile in my experience, and very disgusting to the patient.

Sponging is seldom needed during the operation, unless it is found after removing one or both tonsils, that the patient is not sufficiently anæsthetised to proceed without the exhibition of more chloroform. Should it prove desirable to swab out the pharynx, it is best done with as large a sponge as can be easily thrust into the pharynx with the forefinger, as by so doing more of the accumulated fluid is swept out, and there is less risk of contusion than when holding a small sponge on a holder. Indeed, it is only when over-much sponging is employed, perhaps by a nervous and over-zealous anæsthetist, that real soreness of the throat is complained of afterwards. And where the bleeding is severe, and we are inclined to stop in the process of removing the adenoids until it is arrested, we must remember that the opportunity of spontaneous cessation lies in completion of the operation. We may consequently affirm that the more profuse the hæmorrhage the greater the necessity for a speedy operation.

But besides the fact that the amount of blood lost is in direct proportion to the length of time occupied over the operation, there are two other, and quite as strong, reasons for expedition. The first is found in the risk of blood finding its way into the Eustachian tubes and middle ears, and by its retention inducing an otorrhœa and perforation of the tympanic membrane, and the second lies in the increased risk of a local or general sepsis. For doubtless the more the wounded parts are handled or bruised, the less becomes their power of resistance, and the greater the liability to infection; while the longer the naso-pharyngeal cavity is kept full of blood, the greater the risk of its entering the Eustachian tubes.

As a matter of fact, rise of temperature is an event of the rarest even when, as sometimes happens, one operates under septic conditions in the neighbourhood, such as otorrhœa, or a chronic follicular tonsillitis. Indeed, although I have not infrequently had to operate under such disadvantages, I do not remember that I have ever noticed a rise in temperature that could be traced to such direct cause. Nevertheless everything should be done to secure as clean a condition of the environment as possible. A discharge from the ear should be washed out beforehand, allowing some solution of one-in-forty carbolic acid to instil into the tympanum through the external auditory meatus for half an hour before the operation; but when there is follicular disease of the tonsils it is useless to attempt disinfection.

At the same time, it must be admitted that there is probably considerable risk after these and all operations on the throat and nose of the patient's contracting any infectious disease, the organisms of which are in the atmosphere inhaled by the patient. Scarlet fever appears to be readily contracted, the rash appearing twenty-four hours after the operation. This tallies with the observation made by Paget[1] as regards the rapidity of development of scarlet fever after general operations. Influenza appears to be quickly picked up after operations on throat or nose, and doubtless other contagious diseases would be as easily caught. Therefore I think that the greatest care should be taken to protect the patient from such possibilities; and I now make it a rule when patients come from the country for operation, to refuse to do it in lodgings or hotel, seeing that one can never be sure who may have occupied the rooms previously; and I insist on his coming into a nursing home of the sanitary conditions of which one is assured. As in all surgical procedures, the safety of any operation depends directly upon the care with which the risks can be obviated; and I think this one of avoiding all possible sources of infection of considerable importance. And this conclusion is based not upon theoretical considerations, but upon definite experiences.

But while it is, of course, impossible to secure asepsis at the time of the operation, or to employ antiseptics to such extent as to justify the belief that they would offer any sort of safeguard, every effort must be made to secure perfect cleanliness of hands, instruments, and sponges. The latter should be kept always soaking in one-in-twenty carbolic lotion, and should be taken out of the fluid only immediately before operation. Sufficient number of them should be available to obviate the necessity of washing them during the operation. For my own part I seldom use more than two or three, frequently none at all, though occasionally the hæmorrhage may be so profuse that a dozen or more may be needed. The instruments should be soaked in the same carbolic solution for fifteen minutes before the operation, particular care being taken with the tonsillotomes to secure soap and water cleanliness beforehand, seeing that their complication of parts may render them easy sources of infection.

Little or no subsequent treatment is necessary, beyond, if the breath be fœtid, washing the anterior nares with a weak boric lotion. Healing is usually completed in about ten days, and until this is ensured, the use of the Politzer bag is contra-indicated.

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[1] *Clinical Lectures and Essays*, 1875, p. 349 *et seq.*

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8. Nasal Neuroses

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The nervous supply to the nasal passages subserve several important functions, chiefly those of olfaction, common sensation, and blood-supply; and inasmuch as many physiological reflex phenomena depend on the integrity of this richly innervated territory, it follows that nasal neuroses are both frequent in occurrence and sometimes widespread in origin and effect.

NEUROSES OF OLFACTION

Anosmia.—For the normal perception of odours it is essential (1) that the odoriferous particles should be able to reach the small area of the nasal mucosa containing the olfactory cells occupying the roof of the olfactory fissure and adjacent portions of the outer wall of the septum; (2) that the mucous membrane should be in a moist and normal state; (3) and that the olfactory nerve tract within the cranium be in a normal receptive condition. Hence anosmia may arise (1) from mechanical obstruction to nasal respiration, such as the presence of polypi or other new formations, collections of inspissated mucus, etc.; or (2) from atrophic or other morbid conditions of the olfactory mucous membrane; or (3) from pathological conditions in the region of the olfactory bulb, frontal lobes of the cerebrum, or the cortical centres for olfaction.

It is convenient for clinical purposes to divide cases of anosmia into two classes, as suggested by Zwaardemaker and Schmidt, viz., *Respiratory anosmia,* including those cases due to mechanical causes; and *Essential anosmia,* comprising those cases in which the olfactory nerve tract is the seat of lesion.

Instances of *respiratory* anosmia are those due to inflammatory changes, as in acute rhinitis, or to nasal obstruction from other causes, *e.g.* mucous polypi or other new formation, deflected septum, collections of secretion, rhino-pharyngeal growths, blocking the choanæ narium; while of the second group, *essential anosmia,* we may recall those cases due to the tearing through of the olfactory filaments in the cribriform plate as the result of a blow or jar (Ogle, Legg); neuritis of the olfactory nerves due to influenza, syphilis, etc.; specific irritation, as in those cases ascribed to tobacco-smoke (Parker), to lead (Grant), or to malarial poisoning (Raynaud); of the many intra-cranial causes it is well to remember that congenital absence or other anomalies of the olfactory lobes or nerve filaments have been found, and that anosmia has been observed in cases of tabes dorsalis (Althaus); general paralysis of the insane, in meningitis, abscess, tumours, syphilis, etc.

Again, functional anosmia has been associated with other phenomena of hysteria.

Moreover, reflex anosmia has been observed following removal of both ovaries.

The *symptoms* complained of are inability to perceive odours of flowers, and loss of taste, for the perception of flavours in food and drink depends on the smell. The loss of smell may be partial or complete; it may affect both nasal passages, or it may be unilateral (hemi-anosmia).

In testing the sense of smell it is necessary to use some non-irritating odoriferous substance, such as musk, otto of roses, or vanilla. Irritant vapours, such as ammonia, may be recognised by a patient suffering from anosmia, owing to its stimulating effect for nerves of common sensation as distinguished from the olfactory nerves.

Hyperosmia, or increased sensitiveness to smell, is sometimes observed in hysteria, neurasthenia, and hypochondriasis; it may also result from irritation of the olfactory lobes from various causes.

Parosmia, perversion of the olfactory sense with subjective perception of imaginary odours, is always a central nerve affection. It generally occurs after influenza, and has been noticed in hysterical patients, epileptics, and in insanity.

Cacosmia, the perception of a bad odour, is generally due to the existence of some disease of the nasal passages or accessory sinuses, or to the presence of a foreign body, but more rarely it is subjective and due to disorder of the olfactory nerve tract.

The *prognosis* in olfactory neuroses depends on the nature of the lesion and the length of time that the loss of power of olfaction has existed. When the outcome of some intra-nasal disease which is amenable to treatment the prospect of the functional restoration of the sense of smell is favourable; cases are on record where such restoration has occurred after many years' anosmia, though Morell Mackenzie considered that anosmia which had persisted for two years or more was beyond recovery.

When due to attacks of influenza recovery is possible, notwithstanding that the loss of smell is complete and lasting for many months; parosmia and partial anosmia in the acute stages of influenza or immediately following the febrile attack usually disappears after a few weeks. In all such cases it should be remembered that nasal accessory sinus disease frequently supervenes on influenza, and that perversion of the sense of smell is generally a notable and sometimes the only symptom noticed by the patient in latent "sinusitis."

Hysterical anosmia would be associated with other hysterical stigmata, while anosmia which can be traced to tumours or other organic lesions of the central nervous system, or to commencing insanity, becomes a minor feature in a grave and often irremediable disease.

Treatment.—In cases of purely "nervous" origin, and in those due to intra-nasal disease, but persisting after such causal lesions have been removed, the exhibition of arsenic and strychnine, combined with local galvanisation and local submucous injections of strychnine, are the means which afford the best hopes of success in my experience. It is generally necessary that the treatment should be continued for a considerable period.

Neuroses of Common Sensation and Vaso-Motor Neuroses

The physiological reflexes of the nasal passages, *e.g.* sneezing, lachrymation, and rhinorrhœa, due sometimes to bright light, sometimes to the stimulation of the nasal mucosa, sufficiently indicate that the innervation of the nasal mucous membrane is closely associated with neighbouring regions. But other less obvious relationships are shown, for instance, in the occurrence of sneezing on sexual excitement, the rhinitis following sexual excitement, or sexual excess, the epistaxis which has been known to recur at the menstrual period of some women, and the anatomical differences in the nasal mucous membranes of the bull and the bullock which Jon. Wright has demonstrated.

Hyperæsthesia and Neuralgia.—The nasal mucous membrane is often hypersensitive in patients who suffer from hay fever and other forms of paroxysmal sneezing and rhinorrhœa. The existence of particularly sensitive areas may sometimes be detected by touching with a probe. Neuralgia is sometimes referred to the nose from implication of the branches of the fifth nerve to the nasal passages, but though less common, it is due to much the same causes as facial neuralgia generally.

Paroxysmal Sneezing.—Sneezing is a reflex phenomenon in which three factors co-operate: (1) an external stimulus, (2) excitation of a bulbar centre, and (3) efferent impulses culminating in the act of sneezing. Paroxysmal or excessive sneezing arises from hyperexcitability either peripheral or central, or both. Thus in many cases the pathological factor is some abnormally sensitive area in the nasal passages (sensori-motor), *e.g.* a septal spur; or it is a purely central neurosis (ideo-motor), *e.g.* in "hay-fever" excited by the proximity of artificial flowers; or it is the co-operation of both factors, *e.g.* in cases where bright sunlight and hay pollen cause hay fever (which is only a particular variety of paroxysmal sneezing); for every one is exposed to bright sunlight and hay pollen, but only patients of a nervous temperament suffer.

The *symptoms* hardly require lengthy description; the affection consists merely in an abnormal tendency to sneeze many times in succession with adequate external cause. Some women of the neurotic temperament are subject to attacks of sneezing occurring in paroxysms of thirty to forty sneezes at a time, particularly on rising in the morning. I have had male patients who sneezed one hundred and fifty to two hundred times a day, or more. Such excessive sneezing renders the patient incapable of ordinary mental or bodily exertion, their nervous energy being more or less exhausted in the sneezing attacks. The sneezing is usually accompanied by rhinorrhœa and lachrymation.

Ordinary spasmodic asthmatic paroxysms are very frequently preceded or accompanied by paroxysmal sneezing; in other cases attacks of paroxysmal sneezing alternate with asthma or may replace, for a time, the liability to asthma.

Vaso-motor Rhinitis.—Vascular engorgement of the nasal mucous membrane and of the erectile tissue of the turbinal bodies is liable to occur in young anæmic females, and also in dyspeptic or gouty subjects, and those addicted to alcoholic or sexual excesses.

It may either take the form (*a*) of simple periodic vascular engorgement, or (*b*) of vascular engorgement with coryza and sneezing.

The swelling of the nasal mucous membrane causes intermittent nasal tenosis, and in some cases an external redness and swelling of the nose. In the latter class the middle turbinated body will sometimes be found to press on the septum, and this doubtless accounts in some measure for the external swelling.

Hydrorrhœa (*coryza vaso-motoria periodica*).—This affection, which is characterised by profuse watery discharge from the nose, must be distinguished from the somewhat rare cases of cerebro-spinal rhinorrhœa, or the escape of cerebro-spinal fluid through the nasal passages.

The precise etiology of the affection is not clear, but the patients are generally overworked, neurotic subjects.

In idiopathic rhinorrhœa the flow of fluid from the nose is usually preceded or accompanied by sneezing and lachrymation, itching or pricking sensations in the nose; in other cases the escape of watery fluid is the only symptom. It generally ceases during sleep.

Very large quantities of fluid have been known to run from the nasal passages, and in some cases the fluid has dripped freely, saturating several handkerchiefs during each attack. Indeed as much as two or three quarts may escape in the twenty-four hours. After the flow has persisted for several hours the mucous membrane will be found swollen and œdematous.

The fluid is straw-coloured, and consists of water with traces of sodium chloride and mucus. Unlike cerebro-spinal fluid it does not reduce Fehling's solution.

Coryza Œdematosa.—Closely allied to idiopathic rhinorrhœa is an affection which consists in a serous infiltration of the inferior and middle turbinated bodies, to which Mulhall applied the term coryza œdematosa. The infiltration is sometimes migratory, and in this respect resembles Quincke's œdema. It appears to be associated with digestive disorders in neurotic patients.

Nasal Neuroses associated with Disease in other Regions.—Undoubtedly a large number of cases of spasmodic asthma are associated with either hyperæsthesia and engorgement of the nasal mucosa, nasal polypi, etc., and in a certain number the bronchial affection is due to the intra-nasal disease. On this question see "Asthma."

Many other affections have been reported as instances of nasal neuroses, but in a large proportion the connection is more or less hypothetical. Even when a neurosis has been favourably modified as the result of intra-nasal treatment, it does not necessarily follow that the nervous phenomena were the outcome of the nasal condition, for certain neuroses will often respond to "nerve-shocking" treatment applied to almost any region of the body. But where actual pathological conditions exist in the nasal passages they may well be the determining factor in the occurrence of some affections depending on central nerve instability, and appropriate treatment of the nasal lesion is sometimes helpful if not essential in the successful treatment of the general neuroses. Thus in a few instances epilepsy has seemed to be caused by nasal abnormalities, the removal of which has been followed by cessation of the epileptic seizures; and in one patient, who never had a fit before or since, an ordinary epileptic attack (*grand mal*) ensued while I was applying the galvano-cautery to the nasal passages.

Watson records a case of tachycardia which was apparently produced by nasal polypi; symptoms of Grave's disease (goitre and tachycardia) have vanished after treatment of a rhinitis.

Of ocular affections due to nasal neuroses, it is sufficient to mention that strabismus, myopia, asthenopia, narrowing of the visual fields, photophobia, epiphora, œdema of the lids, blepharospasm, and exophthalmos have been recorded.

Treatment.—The foregoing affections being essentially neuroses, it is always desirable to treat the general matter by hygienic measures, and the exhibition of nervine tonics, such as arsenic, strychnine, phosphorus, valerianate of zinc, etc. In many cases baths or massage, a sea-voyage or change of air, or a visit to a suitable continental spa, will afford a more complete and lasting cure than any local treatment of the nasal passages. But without falling into the error of exaggerating the importance of slight departures from the normal anatomical conformation of the nasal passages, or the sensitiveness of the nasal mucosa, it is always desirable to examine carefully for the existence of any pathological condition in this region which may account for a nasal neurosis, in order that the peripheral factor may be removed. Amongst such local causes the following may be mentioned, viz. (1) marked hypertrophic rhinitis; (2) definite spurs (or deflections of the septum) which are in contact with the turbinal bodies; (3) polypi; and (4) the existence of abnormally sensitive spots.

Even when local abnormalities are found in the nose it is not always easy to determine how far they may be the cause of any associated neurosis, for it is a matter of common observation that all the local conditions just mentioned as possible causes can and do often occur without any concomitant nervous phenomena. The local application of cocaine is often a useful guide on this point, for if the neurosis is definitely relieved by the local anæsthetic, and reasserts itself as the effect of the cocaine passes off, then appropriate local treatment is generally desirable.

In rhinal hydrorrhœa the repeated local application of the galvanic current, one pole being in contact with the nasal mucous membrane, has proved successful; local hypodermic injections of atropine and strychnine also have resulted in cure.

The local application of cocaine in cases of nasal neuroses, while often useful for diagnostic purposes, should not be resorted to as a curative measure: the drug may mask such affections for a time, but the relief is only temporary, and is liable to be followed by aggravation of the symptoms, while the risk of inducing a cocaine habit is never to be ignored in the treatment of any neurosis.

Further, one should never overlook or disregard the existence of any underlying dyscrasia; thus paroxysmal sneezing, vaso-motor rhinitis, and asthma may be due to goutiness, dyspepsia, and portal congestion.

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9. Inflammatory Affections of Accessory Sinuses

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Anatomy and Physiology.—The accessory air sinuses which lie in relation to the nasal cavities, and which communicate with each nasal chamber, are named as follows:—The maxillary sinus, the frontal sinus, the anterior and posterior ethmoidal cells, and the sphenoidal sinus. These air spaces, both on anatomical and clinical grounds, may be conveniently considered as forming two groups, a subdivision which is based upon the relative position of their orifices of communication with the nose. In the first group are the maxillary, the frontal, and the anterior ethmoidal sinuses which open into the middle meatus of the nose below the line of origin of the middle turbinated bone (Fig. 2). In the second group are the posterior ethmoidal cells and the sphenoidal sinuses communicating with the nasal cavities above the middle turbinated bone, the former opening into the superior meatus, the latter into the spheno-ethmoidal recess. This recess is situated on the outer wall of the nasal chamber behind the superior turbinated bone, in front of the body of the sphenoid bone, and above the superior meatus (Fig. 2). When pus is seen in the middle meatus on anterior rhinoscopy, its source must be suspected in the sinuses of the first group; when it is seen in the olfactory cleft, the narrow interval between the middle turbinated bone and the septum nasi, attention should be turned to the posterior group of cells. These cavities are lined by a thin muco-periosteal membrane continuous through their ostia with the lining membrane of the nasal cavities.

The Maxillary Sinus or Antrum of Highmore is a cavity constantly present in the body of the upper jaw bone. It has a roof, a floor, and three walls. *The roof* is a thin plate of bone, the upper surface of which forms the floor of the orbital cavity. It contains the canal for the superior maxillary nerve and the infra-orbital vessels. *The floor* is formed by the alveolar process of the upper jaw, and has an important relation to the teeth. As a rule the floor of the antrum and the floor of the nasal cavity lie on the same horizontal plane. The layer of spongy bone between the roots of the teeth and the antral cavity varies in thickness in different skulls, and often on the two sides of the same skull; it is rare to find a direct communication between the roots of the teeth and the mucous membrane of the antrum. The relation of the teeth to the floor of the cavity varies according to the dimensions of the sinus. The three molar teeth bear the most constant relation to the floor, while the second bicuspid comes next in frequency (Fig. 1).

The posterior wall of the maxillary sinus is a thin plate of bone which intervenes between that cavity and the zygomatic fossa.

The inner or nasal wall is clinically of considerable importance. That portion which lies beneath the attachment of the inferior turbinated bone, and forms the outer wall of the inferior meatus, consists of a thin layer of bone; it is thinnest immediately below the turbinated where it offers the most favourable site for exploratory puncture of the sinus. Above the inferior turbinated bone the nasal wall forms the outer boundary of the middle meatus, and is partly osseous, partly membranous. In this region is situated the maxillary opening (*ostium maxillare*). It lies immediately beneath the roof of the antral cavity, a position which does not favour free drainage through it (Figs. 1 and 4). Under cover of the middle turbinated bone it opens into the infundibulum (Figs. 1 and 4), a canal on the outer nasal wall, which also receives the orifices of many of the anterior ethmoidal cells, and usually also the duct leading from the frontal sinus in many cases. The infundibulum in its turn communicates with the middle meatus through the hiatus semilunaris—a narrow slit-like opening, bounded above by the

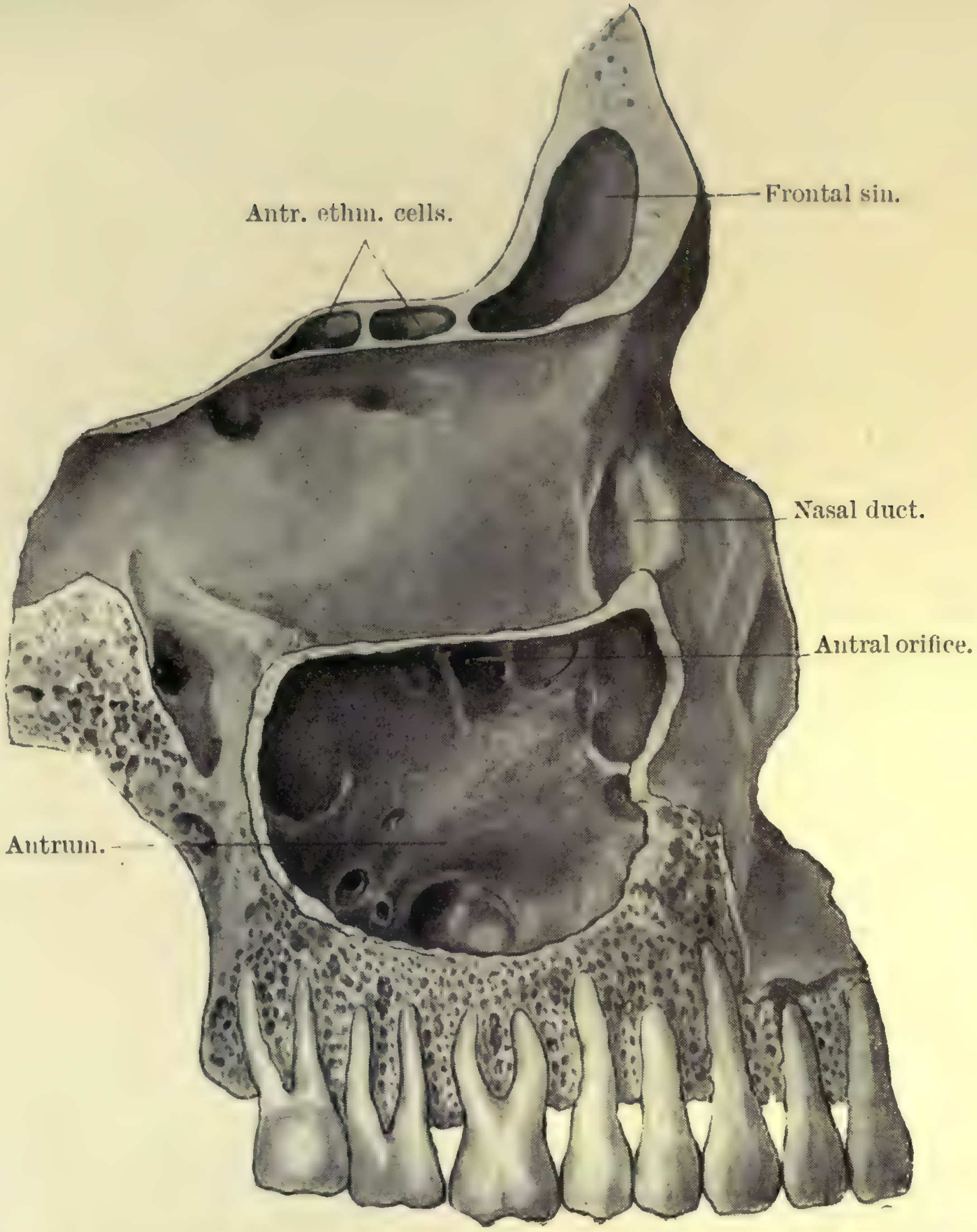

FIG. 1.—Dissection showing right maxillary antrum opened upon its outer aspect. The maxillary ostium is seen situated in the highest part of the cavity immediately below its roof. The outer table of bone is removed in order to show the relation of the fangs of the teeth to the floor of the antrum.

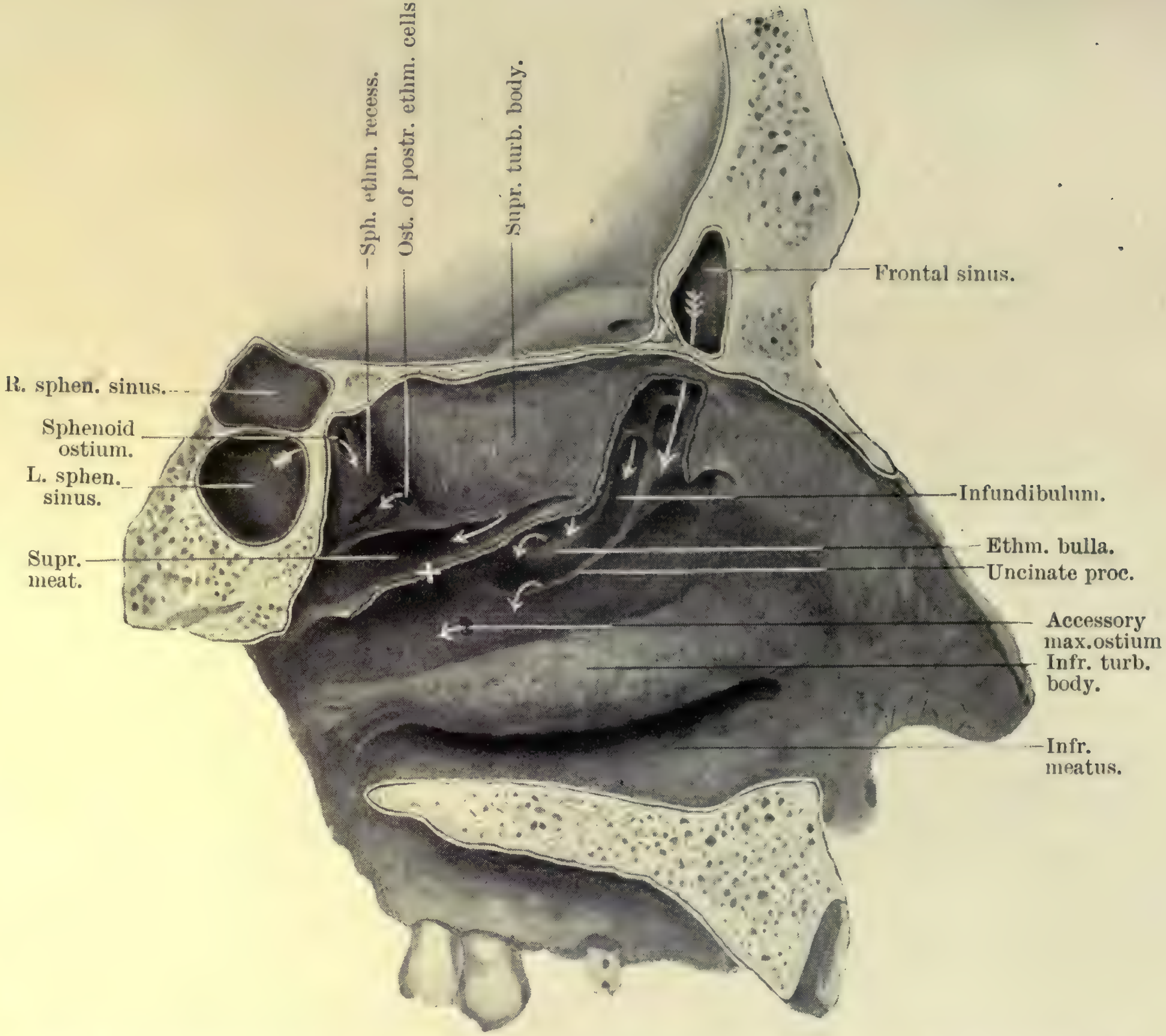

FIG. 2.—Dissection showing outer wall of left nasal chamber. The various arrows indicate the position of the ostia of the sinuses. The middle turbinated body has been removed along the line indicated by the cross +. In this way the ostia communicating with the middle meatus are brought into view. The long arrow passing downwards from the frontal sinus shows the naso-frontal duct opening directly into the middle meatus in front of the infundibulum.

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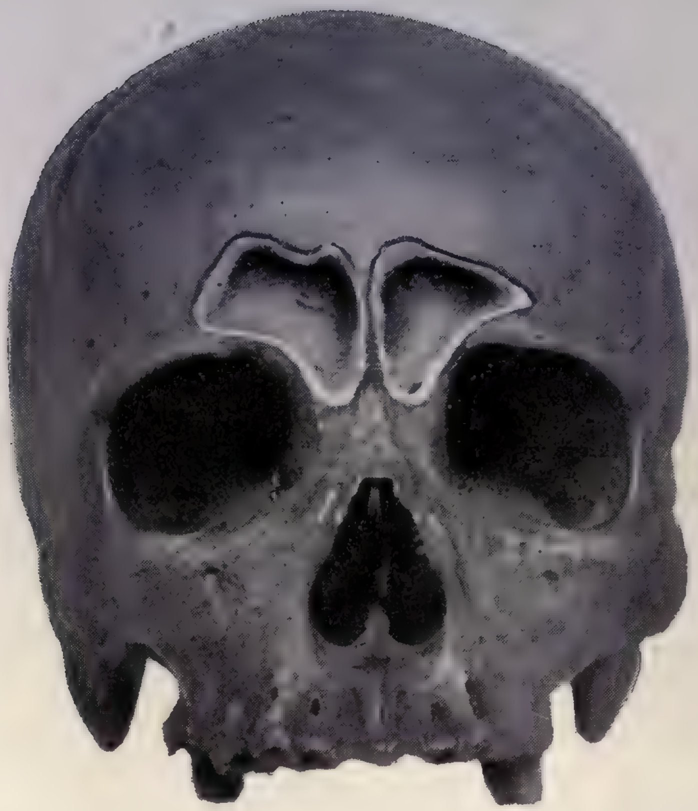

FIG. 3.—Skull showing anterior wall of both frontal sinuses removed. The two cavities are of average dimensions: the septum is mesial in position. The small dark area in the left sinus immediately above the nose indicates the position of the ostium frontale

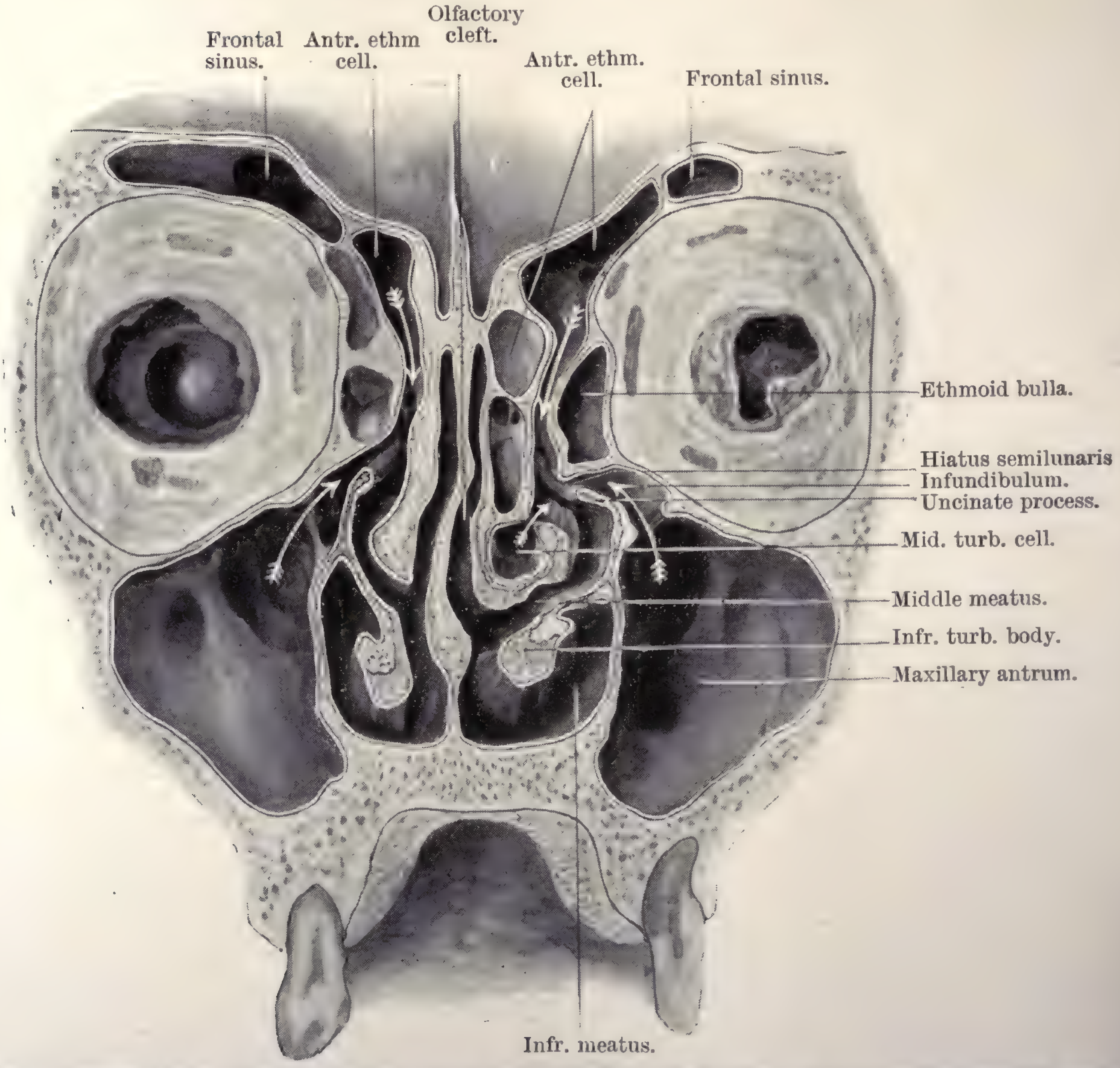

FIG. 4.—Drawing from dissection kindly lent to author by Prof. Symington. It is a vertical coronal section through the nasal chambers and maxillary antra on the plane of the antral orifices, through each of which an arrow passes into the infundibulum. The close relation of the frontal, anterior ethmoidal, and maxillary sinuses to the orbit is also seen. The communication between the anterior ethmoidal cells and the turbinal cell on the right side with the middle meatus of the nose is indicated by arrows.

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ethmoidal bulla, below by the uncinate process (Fig. 2). Sometimes an accessory maxillary opening exists, which lies at a lower level than and posterior to the infundibular opening (Fig. 2). It communicates directly with the middle meatus immediately above the posterior half of the inferior turbinated bone. In some cases of antral suppuration the discharge mainly passes backwards into the naso-pharynx, an occurrence probably explained by the existence of this accessory opening.

The anterior or facial wall is thin. In front, this surface is marked by the canine ridge, immediately behind which is the canine fossa, through which the antral cavity is frequently opened. The maxillary sinus varies in size in different skulls, and sometimes also on the two sides of the same skull. It may be diminished by an undue approximation of its facial and nasal walls, or from a want of absorption of the bone during its development. In the latter case the walls of the cavity may be of considerable thickness. It is very rarely either completely or incompletely subdivided by partitions.

The Frontal Sinuses are situated in the frontal bone immediately above the root of the nose, and extend upwards and outwards upon the forehead and backwards along the roof of the orbit, subject to very considerable variations in size and shape (Fig. 3). They are not present at birth, and probably do not exist before the seventh year of life. One or both sinuses may be absent. Each cavity has three walls—anterior, posterior, and inferior. The anterior is the thickest, varying from 1-5 mm. The inferior wall or floor is the thinnest, so that secretion retained in the cavity tends to make it bulge. The thickness of the walls varies in different skulls and on the two sides of the same skull. A bony septum, which is very rarely incomplete, intervenes between the two sinuses. It is usually mesial in position, but may deviate to one or other side of the mesial plane. In marked cases of deviation the obliquity of the septum leads to considerable asymmetry of the sinuses—in some cases one cavity extending so far across the mesial plane of the forehead as to reduce the other to a mere slit. In such cases the surgeon may fail to open the diseased cavity when operating through the anterior wall. The following measurements sufficiently indicate a sinus of average size: height (1¼ in.) from the lower end of the fronto-maxillary suture vertically upwards; breadth (1 in.) from a mesial septum horizontally outwards; depth (¾ in.) from the anterior wall of the cavity backwards along the orbital roof. The dimensions vary considerably independently of the degree of development of the glabella and supraciliary ridges. Thus the sinuses may exist merely as recesses limited to a small area above the nose. On the other hand, the cavity may extend upwards on to the forehead for more than two inches, while externally it may be limited by the bony wall of the temporal fossa and reach as far back as the optic foramen in the roof of the orbital cavity. By the aid of transillumination, to be afterwards described, the extent of the cavities can be delineated on the forehead in many individuals. The interior of the sinus may present considerable irregularities; incomplete partitions often exist, giving rise to the formation of pockets. Such diverticula are frequently found towards the external angle of the sinus. Special attention should be paid to this region and to the backward extension of the floor along the orbital roof in the operative treatment of chronic suppuration. A sinus may be almost completely subdivided by a vertical, or to a lesser extent by a horizontal bony partition, each subdivision communicating with the nose. Each sinus communicates at its most dependent part with the nasal cavity (Fig. 2). The ostium frontale forms the upper end of the naso-frontal duct which leads downwards into the infundibulum of the nose.

The *Ethmoidal Cell Labyrinth* is mainly contained in the lateral mass of the ethmoid bone, but it may extend upwards into the frontal bone, backwards into the sphenoid, and inferiorly into the superior maxillary bone. It is divided into an anterior and posterior group of cells, there being as a rule no intercommunication between the two groups. The relative space occupied by each set of cells and the number of cells in each vary considerably. The subdivision is based upon the position of the different openings communicating with the nose. Some of the anterior ethmoidal cells open directly into the middle meatus, others again open into the infundibulum, and thence through the hiatus semilunaris into the meatus. The posterior ethmoidal cells communicate with the superior meatus (Fig. 2). The ethmoidal cells have an important relation to the orbit, the os planum of the ethmoid bone forming both the outer wall of the labyrinth and the inner wall of the orbital cavity (Fig. 4). Certain of the anterior ethmoidal cells have received special names, thus: a large cell situated on the inferior aspect of the lateral mass is termed the ethmoidal bulla; the ethmoidal cell which occasionally extends upwards and forms an elevation upon the floor of the frontal sinus is designated the frontal bulla; lastly, an air space is sometimes present in the anterior end of the middle turbinated bone which is spoken of as the turbinal cell (Figs. 2 and 4).

The *Sphenoidal Sinuses* occupy the anterior portion of the body of the sphenoid bone (Fig. 2). The two cavities are separated by a mesial, vertical bony partition, which is usually complete. The cavities vary in size in different skulls. The larger the cavity the thinner are its walls, and *vice versa,* a fact which may considerably influence the symptoms produced by an inflammatory affection within the sinus. The anterior wall is thin, and forms the posterior part of the roof of the nose. It contains the orifice of the sinus, which is situated considerably above the floor of the cavity, sometimes close to the intervening septum, in other cases nearer the outer lateral wall of the cavity. It communicates with the spheno-ethmoidal recess (Fig. 2). The *posterior wall* abuts upon the basi-occipital bone. The *roof* of the sinus has important relations to certain intra-cranial structures lying upon the basis cranii, namely, the optic chiasma, the pituitary body, and even the pons Varolii. The optic nerve and ophthalmic artery are situated in the angle between the roof and external lateral wall of the sinus. The intervening layer of bone may be extremely thin. The *floor* of the sphenoidal sinus forms part of the roof of the nasal chamber. The *inner* or mesial wall is the septum between the two cavities. It may be considerably deviated from the mesial plane. The *external lateral wall* lies in relation to certain cranial nerves, the third, fourth, the ophthalmic, and sometimes the superior maxillary divisions of the fifth nerve, also the sixth nerve, and the ophthalmic vein.

Different views have been held at various times with regard to the function of these cavities. Some have looked upon them as being concerned in the function of smell, while others believed that they assisted in respiration. No importance can be attached to either of these views. In all probability they serve as secondary resonating chambers for the voice.

2. Etiology.—Inflammation and suppuration in the nasal sinuses may arise in the course of certain acute affections, such as influenza, pneumonia, scarlet fever, measles, typhoid fever, diphtheria, small-pox, and cerebro-spinal meningitis. The inflammation may reach the sinus by direct extension from the nose, fauces, and naso-pharynx, or the cavities may become involved

through the blood stream in the course of a general systemic infection. E. Fränkel's investigations have shown the frequency of sinus complications in croupous pneumonia, while the great importance of influenza as a causative factor has now been demonstrated beyond all dispute. There is no doubt that an actual increase in the number of cases of purulent sinus disease is due to the greater frequency and prevalence of the influenza epidemics. In the epidemic of 1890 Weichselbaum found suppuration present in a large number of post-mortem examinations upon influenza patients, while Garel has given us a clinical record of a series of cases of acute inflammation of the maxillary and frontal sinuses which occurred during the epidemic of 1899-1900. In cases of acute coryza, in which there has been no reason to suspect an influenzal infection, sinus inflammation may complicate the "cold." Suppuration has also been ascribed by Weichselbaum to an attack of facial erysipelas. It is more reasonable, however, when these conditions are associated, to regard the erysipelas as secondary to the nasal discharge. Passing from these acute conditions, we find that suppuration in the sinuses is sometimes associated with such chronic affections of the nose as syphilitic ulceration, benign and malignant growths. Tuberculous disease of the accessory cavities appears to be rare, although Neumayer and Réthi have recorded two or three cases in which tubercle of the maxillary sinus occurred in association with, but secondary to, tubercle of the gums and nasal mucous membrane. Lapalle, who examined the sinuses in fifty-nine cadavera, in which death was due to pulmonary or meningeal tuberculosis, found sinus disease in nineteen instances, but no facts are furnished indicating that the latter condition was tuberculous. The relation of ozæna to accessory cavity suppuration is still a vexed question; in a certain number of cases the two conditions are associated, but the relation of cause and effect is still debated. Suppuration has been ascribed to nasal polypi, but in the majority of cases in which these conditions coexist, the latter are of secondary origin, and result from the constant irritation to which the mucous membrane is subjected from the flow of pus over it. In the case of the antrum dental caries is an important etiological factor, though even on this point all are not agreed as to the relative frequency of a dental or nasal origin in antral suppuration.

Inflammation may be due to trauma consequent upon fractures of the sinus walls. It may also follow such operations upon the nasal chambers as the removal of polypi, and the injudicious and prolonged insertion into the nose of cotton-wool or gauze plugs, *e.g.* in controlling epistaxis. Further, the extraction of teeth and the resection of the superior maxillary division of the fifth cranial nerve, as reported by Langenbeck, have set up inflammatory mischief in the antrum. It is very important to remember, too, that the pus from one sinus may infect another. The intimate anatomical relations between the various ostia sufficiently indicate how this may arise, while the non-recognition of this fact may lead to failure in treatment. The possibility of infecting the anterior ethmoidal cells or frontal sinus from too forcible syringing of the antral cavity must also be borne in mind.

3. The BACTERIOLOGY of accessory sinus inflammation has been studied both in the living subject and upon the cadaver, and a number of organisms have been described in connection with it. We are mainly indebted to the work of Weichselbaum and E. Fränkel for our knowledge of this subject, although a number of workers have recently turned their attention to the same field. Amongst the various organisms may be mentioned the *diplococcus pneumoniæ* (Fränkel's *pneumococcus*), the *pneumo-bacillus* of Friedländer, the *bacterium coli*, and a number of pyogenic organisms, varieties of *streptococci*

and *staphylococci.* The influenza bacillus has been demonstrated by Lindenthal, Howard and Ingersoll and Moskowsky. An interesting case has recently been recorded by Luc, in which the pneumococcus alone was found in acute inflammation of the frontal and maxillary sinuses. The patient was infected while conducting a post-mortem examination upon a case of cerebro-spinal meningitis, from which the pneumococcus was cultivated. Howard and Ingersoll failed to find the tubercle bacillus in a number of cases of chronic suppuration examined with that object in view. True diphtheritic membrane has been found in the antrum by Weichselbaum, E. Fränkel, Dmochowsky, and Pearce. The last-named investigator has made some very interesting post-mortem observations upon a number of cases of uncomplicated diphtheria, and of diphtheria associated with measles or with scarlet fever. In considerably more than half of the unmixed cases of diphtheria inflammatory changes were found in the antra, and the Klebs-Loeffler bacillus was present in all but three. In three of the four cases complicated with scarlet fever the antra contained pus in which streptococci and staphylococci were found. These observations, however, refer only to fatal cases. Some interesting points worthy of more extended research have lately been published by Stanculeanu and Baup. These observers have divided sinus suppurations into two groups, those primarily due to dental caries in which the organisms found were mainly anaerobic, *e.g. bacillus ramosus, perfringens, serpens,* etc., and those of nasal origin, in which the organisms were chiefly aerobic, *e.g. pneumococci, streptococci, staphylococci.* In the former the pus was fœtid, in the latter non-fœtid.

4. Pathology.—Inflammation of the accessory nasal sinuses may be acute or chronic, and be induced by those organisms to which we have already referred. It is characterised by such changes as are usually associated with inflammation of mucous membranes. These vary with the severity of the infection, and are modified according to the patency or occlusion of the orifice of the cavity. In acute inflammation the mucosa becomes congested, infiltrated with round cells, and swollen, while a serous exudation is poured out, constituting an acute catarrh of the membrane. This exudation may become sero-purulent or purulent, and if mixed with a quantity of mucus it presents a muco-purulent character. If the ostium of the sinus becomes blocked by the swollen mucous membrane, the exudation is retained under tension, and the clinical symptoms and signs become aggravated. Distension of the bony wall of the cavity, where there is least resistance, may occur, and in some cases be followed by perforation, and the formation of a fistula and its sequelæ. Spontaneous cure may result; on the other hand the inflammatory process may become chronic. In many cases the affection is not recognised clinically until this stage is reached. When a chronic suppuration exists various secondary changes are met with in the mucous membrane. The round cell infiltration already referred to may be followed by the formation of new fibrous tissue, causing thickening of the membrane. The mucous glands are to a large extent destroyed, while cysts varying considerably in size are formed by dilatation of the gland ducts, or even of the acini themselves. The mucous membrane frequently presents a uniformly swollen gelatinous appearance. Not infrequently this condition is associated with the presence of numerous soft polypoid processes, which vary considerably in size and in number, and may even fill up the interior of the cavity. Occasionally a single polypus is met with in the sinus. In consequence of the swollen œdematous condition of the lining membrane the ostium of the cavity may become partially blocked and the free drainage of pus interfered with. The deeper periosteal layer also becomes involved,

leading either to a plastic or a destructive process in the subjacent bone. While caries of the osseous wall is met with, and sometimes necrosis, it is undoubtedly the case that in a very large number of cases no destruction of bone occurs, which is probably accounted for by the fact that the bony walls of these cavities are provided with a periosteal covering on each aspect.

In consequence of destruction of the bone perforation of the sinus wall may result, and various complications follow. A communication may thus be established between the antrum and ethmoidal cells, or between these cells and the frontal sinus. In a similar way the frontal sinus, ethmoidal cells, and antrum may communicate with the orbital fossa, and fistulous tracks result therefrom (Fig. 4). Implication of the orbit and the formation of a secondary abscess in that cavity may lead to temporary or permanent injury of the eyeball and its adnexa, and may prove the starting-point of intra-cranial complications. Orbital cellulitis with abscess formation may occur without any perforation of the bone, infection taking place through the blood or lymph channels. Within the nose itself alterations in the mucous membrane are frequently observed. These consist in the development of polypi in the middle meatus and in its vicinity. They may completely block the nasal chamber or be insignificant in size. The nasal lining membrane generally presents a swollen and reddened appearance, while the inferior turbinated body may be turgescent: these intra-nasal changes probably result from the irritation of the purulent nasal discharge.

Intra-cranial complications may be secondary to suppuration in any of the accessory sinuses, though not so often in connection with antral disease. Although more frequently due to chronic affections, their occurrence in acute cases must not be lost sight of. The infection occurs as the result of caries and destruction of the sinus wall, thus establishing a direct communication with the cranial cavity, or it may spread inwards through venous channels or lymphatic vessels of the diplöe without any macroscopic evidence of the path of infection. In some cases the mischief passes from the orbit along the ophthalmic veins to the cavernous sinus. Perforation of the posterior wall of the frontal sinus or of the roof of the sphenoidal sinus may be followed by extra-dural, subdural, or cerebral abscess, by purulent basal or general meningitis, by thrombosis of the cavernous, petrosal, and superior longitudinal sinuses, or by a combination of two or more of these complications. An ever increasing number of fatal cases with the primary source of infection in the nasal sinuses is being recorded, and in many instances the real cause of the intra-cranial complication has only been revealed at the post-mortem examination.

5. ACUTE INFLAMMATION IN THE ACCESSORY SINUSES.—Acute inflammation and suppuration of one or more of these cavities probably occur more frequently as concomitant complications of acute coryza, influenza, and certain of the exanthemata than is generally supposed to be the case. The onset of the inflammation may be masked by the severity of the coryza which precedes or accompanies it. Sometimes the patient's attention is drawn to the fact that during the acute stage of the cold the muco-purulent discharge is more than usually copious, perhaps especially so from one nostril, and further, that it continues for a longer time than is customary. The symptoms commonly associated with acute inflammation in the accessory cavities are considerably modified according as the ostium of the cavity remains patent or becomes closed from swelling of its mucous membrane. In the former case the secretion drains away more or less freely, and a spontaneous cure frequently results, while in the latter case there is retention and consequent aggravation of the symptoms.

(*a*) *The Maxillary Sinus.*—The symptoms of an acute coryza may be characterised by severe neuralgia in the cheek and forehead of the affected side, the pain in some of these cases being associated with a considerable degree of photophobia. A rigor and a rise of temperature sometimes precede the onset of the pain, and tenderness may be elicited upon pressure over the cheek or upon the gums. The severity of the symptoms may then be greatly diminished by a sudden and copious flow of secretion from the corresponding nostril. The discharge varies in character, being perhaps at first serous or slightly blood-stained, but becoming muco-purulent or purulent; from the first it may consist entirely of thick creamy pus. Cessation of the flow of pus may be followed by an exacerbation of the symptoms, again to be relieved by a sudden return of the discharge. This alternation in the character of the symptoms is very suggestive of the condition. The discharge gradually diminishes in quantity with a corresponding amelioration of the pain and local discomfort, and after a varying period of time either a spontaneous cure results or the condition becomes chronic. In other cases, again, operative interference is demanded before any relief can be obtained. Orbital complications seldom arise in connection with acute antral suppuration: they are evidenced by severe pain in the eye, displacement of the globe, and the formation of pus in the surrounding cellular tissue.

If the nose be examined by anterior rhinoscopy in a case of this kind, the mucous lining on the affected side is probably found red and swollen, and the inferior turbinated body turgescent. Inspection of the middle meatus may reveal a drop of pus in that situation, increasing in quantity after the head has been inclined forwards. Trans-illumination is of considerable diagnostic value: if opacity of the cheek and absence of the subjective light sensation in the eye of the affected side exist in conjunction with the symptoms and signs enumerated, the diagnosis of antral suppuration is almost certain. In connection with illumination of the antrum in these cases, it may be pointed out, that the diagnosis of acute periostitis of the upper jaw, due to a diseased tooth and producing symptoms somewhat resembling those of antral suppuration, may be aided by this test. In this condition the patient may experience a subjective sensation of light in both eyes, and inspection of the interior of the nose will reveal an absence of the objective signs above described. Should the ostium maxillare be blocked in antral suppuration, a differential diagnosis might still prove uncertain and necessitate an exploratory puncture.

Schmiegelow, Röpke, and others, have reported a few cases of acute inflammation of the superior maxillary bone occurring in infants a few weeks after birth. The symptoms thus presented are severe. The onset of the illness is sudden and is ushered in with fever, accompanied by redness and swelling of the cheek and eyelids, followed by discharge of pus into the nose and mouth, or on to the face through one or more openings. Necrosis of part or even of the whole of the upper jaw-bone may occur, numerous small sequestra becoming detached. These cases present the signs of acute osteomyelitis of the upper jaw-bone as Schmiegelow first pointed out, a condition which some writers, however, have described as acute suppuration in the antrum. Neither on anatomical nor on clinical grounds can this latter definition be regarded as correct.

(*b*) *The Frontal Sinus.*—Acute inflammation of the lining membrane of this cavity is ushered in by symptoms which closely resemble those described in connection with the antrum. Fever and general malaise are accompanied by intense frontal headache and a feeling of weight and oppression above the eye, and sometimes a sensation of fulness behind it. Percussion immediately above the inner third of the supra-orbital margin on the suspected side elicits tenderness, a symptom, however, which is rendered much more acute when the floor of the sinus is pressed upon. Redness and swelling of the skin over the cavity, along with slight œdema of the upper eyelid, may afford further evidence of some deep-seated affection. In the absence of external signs, or when the patient is seen before there has been any nasal discharge, the case may easily be mistaken for one of severe neuralgia. A sudden discharge of pus into the nose is followed by abatement of the symptoms and the patient feels better. Anterior rhinoscopy may reveal a condition very similar to what is seen when the antrum is affected. Some observers obtain considerable assistance in acute cases from trans-illumination of the frontal sinus, finding the affected cavity opaque or considerably darker than on the opposite side. If, in conjunction with these phenomena, the maxillary sinuses illuminate, the diagnosis of frontal sinus suppuration is still further established.

Should the ostium frontale become blocked a more serious train of symptoms may supervene. As the thin bony floor of the sinus offers least resistance, expansion of this wall follows most readily, with the formation of a fluctuating swelling in the upper and inner angle of the orbit. Exophthalmos, and a downward and outward displacement of the eyeball along with certain visual disturbances, may follow distension of the cavity. Rupture of the bony wall may take place with the formation of an orbital abscess. Perforation of the posterior sinus wall followed by intra-cranial mischief is a rare complication in acute cases.

(*c*) *The Ethmoidal Cells.*—Acute suppuration, whether occurring in the ethmoid labyrinth or limited to the cell of the ethmoidal bulla or of the middle turbinated bone, is not frequently met with. Grünwald reports two cases in which a limited suppuration of this kind occurred. Both patients suffered from headache and severe pains in the forehead, and complained of nasal discharge, which in one of the cases was for some days of a watery nature, afterwards becoming purulent. Examination of the nose showed the mucous membrane to be red and slightly swollen, and pus was visible upon the middle turbinated body. Irrigation of the nose and the establishment of a free exit for the pus permanently removed the symptoms. Jeaffreson reports an acute case, with sudden onset, occurring during convalescence from scarlet fever. The patient was seized with rigors, fever, headache, and cerebral symptoms. In a few days there was exophthalmos of the right eye with defective vision and double optic neuritis. An incision made on the inner side of each orbital cavity evacuated pus. The abscesses were found to communicate. In twenty-four hours all acute symptoms disappeared.

(*d*) *The Sphenoidal Sinus.*—Acute inflammation of this cavity has not been very frequently recognised clinically; several cases, however, have been described by Schäffer. The symptoms resembled those of an aggravated nasal and naso-pharyngeal catarrh, the patient complaining of intense headache in the occipital region and on the vertex of the skull. Accompanying this there were symptoms of sleeplessness and general malaise, and the temperature rose above that usually met with in an ordinary cold. In some cases giddiness was a prominent symptom. If an objective examination should be made in the acute stage the mucous membrane in the posterior part of the nose will be found red and turgescent, the olfactory slit between the middle turbinated, and the septum being narrowed by the swollen condition of the mucosa. Muco-purulent and purulent secretion may be also visible both by anterior and posterior rhinoscopy, but there are no crusts such as occur in the chronic form of the affection.

(*e*) TREATMENT OF THE ACUTE AFFECTIONS.—Acute suppuration in the accessory sinuses may heal spontaneously, or may pass into a chronic condition. Some cases require early surgical interference owing to the acute and threatening character of the symptoms. The duration of this stage varies considerably, and is dependent not only upon the severity of the infection, but on certain anatomical conditions which favour imperfect drainage. Amongst these may be enumerated the position of the ostium, as in the antrum, the small size of the openings, and incomplete subdivisions of the cavity due to partitions. I have seen acute suppuration of the frontal sinus heal without any surgical operation after the discharge had persisted for seven weeks, while an acute antral suppuration seen a week after its onset and treated by palliative measures lapsed into a chronic condition. In the treatment of the acute stage various simple remedies are employed, mainly with the object of reducing the nasal turgesence and thus favouring freer drainage. The patient should be confined to bed, and in the case of the maxillary and frontal sinuses hot compresses or ice applied to the cheek and forehead often relieve the pain to some extent. Frequent inhalations of menthol vapour, prepared by adding menthol crystals to hot water or administered in a 10 per cent alcoholic solution from an inhaler, greatly relieve the symptoms. A weak cocaine spray 2 to 3 per cent effects a similar purpose. The internal administration of salol is also by some strongly recommended.

The severer cases, however, require careful watching, and if the symptoms are very acute it may be necessary to open the sinus or enter it through the natural orifice and wash out the contents. Complete and permanent relief has resulted from a single irrigation in such cases. If the pain continues severe or head symptoms supervene, operation should not be delayed. The formation of an orbital abscess must be at once dealt with. Opinions differ as regards the time of opening the sinus in the less severe cases where, after the disappearance of all subjective symptoms, the purulent discharge continues. Avellis is in favour of operating after three weeks, while others recommend delay for six weeks. In the frontal sinus case referred to above the discharge ceased spontaneously after seven weeks. In all cases the surgeon must be guided both by the amount and the character of the pus. If it recurs in gradually diminishing quantities and becomes less purulent, even though it continues over a period of several weeks, operation may still be safely delayed. The methods of operating upon the different sinuses are described under the treatment of chronic suppuration. In acute cases, however, curetting of the interior of the cavity is not necessary, and the condition tends to heal without prolonged after-treatment.

6. DIAGNOSIS OF CHRONIC SUPPURATION IN THE ACCESSORY SINUSES OR SO-CALLED "LATENT EMPYEMA"

(i.) GENERAL SYMPTOMATOLOGY.—A brief résumé of certain symptoms and signs which should suggest the possible existence of chronic suppuration in one or more of these cavities must in the first place be considered. It is of primary importance, however, to bear in mind the fact that pus may be secreted for months and even years in one of the accessory sinuses, with almost entire absence of pain or swelling to suggest the existence of such an inflammatory condition. The term "latent empyema" has in consequence been applied to this affection. On the other hand, a more general recognition of the fact that a purulent nasal discharge with or without some degree of nasal obstruction—especially if the discharge is unilateral—may be due to sinus mischief, has led to a more systematic and successful examination of these air spaces. In complicated cases in which more than one sinus is affected, a correct and complete diagnosis is by no means easy, and careful and repeated observation becomes necessary before a knowledge of the exact condition is ascertained. Even when only one sinus is diseased diagnosis is sometimes difficult.

(*a*) *Nasal Discharge.*—This may be the chief or perhaps the only symptom complained of. It is often difficult to ascertain the date or manner of its origin. The patient may complain that he has a "chronic cold" which has lasted for many months or even years. The discharge varies in character. In some cases it is mainly purulent, being of a thick creamy consistence and yellow in colour. In others, again, it is thinner and more stringy owing to a considerable admixture of mucus, and sometimes the mucus predominates, rendering the secretion clear but of a tenacious consistence. Killian has laid stress in diagnosis upon the green colour of the pus from the frontal sinus; but too much diagnostic importance must not be attached to any of the physical characters of the nasal discharge. The patient may complain that at times he both expectorates and removes with the aid of his handkerchief small crusts; there is a greater tendency for the discharge to dry into crusts in sphenoidal sinus disease, and according to Hajek the same thing is noticed in ethmoid cell suppuration. He may complain, too, of a fœtid odour, and further, that the discharge which passes into the throat has a bad taste. In one of my cases the patient was conscious of the fœtor in one nostril only. When a bad odour alone is complained of, a suspicion of a possible maxillary sinus suppuration should be aroused, as occasionally that constitutes the only subjective symptom met with. In some cases even of long-standing antral suppuration the discharge is not fœtid. As a diagnostic aid it is important to bear in mind that in sinus disease the sufferer is conscious of the odour while his neighbours are not; in fœtid atrophic-rhinitis, on the other hand, the opposite is usually the case, the sense of smell being destroyed in the latter affection. The two conditions, however, sometimes coexist; further, in sinus suppuration the nose may be so blocked with polypi that the sense of smell is lost.

The discharge may be unilateral or bilateral; its presence in both nasal chambers does not necessarily imply a bilateral affection, as it may be blown forward from the naso-pharynx into the healthy side. On the other hand, at least one case has been reported in which unilateral nasal discharge occurred although both frontal sinuses were affected. The flow of pus is often more or less intermittent, being worse when the patient stoops; again, it may accumulate in the throat in the morning. This intermittency influenced by posture is suggestive of the antral origin of the discharge; a more constant flow may be in favour of its frontal source. Further, in some antral cases, the discharge passes mainly if not entirely backwards into the naso-pharynx and pharynx, this symptom constituting the patient's chief complaint. This may depend upon the existence of a large accessory antral opening, which serves to drain the cavity in a backward direction. Pus from the posterior ethmoidal and sphenoidal cells tends to pass in the same direction, while from the frontal sinus the flow is mainly forwards.

(*b*) *Nasal Obstruction* may or may not accompany sinus suppuration, being dependent mainly on the presence of polypi; it may be unilateral or bilateral, partial or complete. The patient sometimes complains of its intermittent character, due in all probability to the varying amount of turgescence of the inferior turbinated bodies.

(*c*) *Pain* is a very variable symptom, and as already indicated may be absent throughout the whole course of the disease. It may be of the nature of headache, facial neuralgia, or toothache, sometimes slight, at other times occurring in severe paroxysms, often periodic in character. Some patients complain of a weight or fulness in the forehead, aggravated on stooping; others have associated with this an inability to concentrate their thoughts for any length of time, while mental work merely induces headache; mental depression sometimes accompanies ethmoid disease. Such symptoms may be entirely due to nasal obstruction, as they may disappear after the removal of the polypi, a fact which is also observed when free respiration through the nose is established in cases in which there is no sinus affection. Too much importance should not be attached to the seat of the pain in this class of case. When this symptom is complained of in chronic antral suppuration it is most commonly located in the supra-orbital region; frontal headaches are just as frequent in ethmoidal as in frontal sinus disease, while in the latter condition occipital pain has been in several instances noted. In sphenoidal sinus disease pain may be complained of on the vertex, but occipital headache or painful sensations referred to the back of the eyes are also met with. The frequent combination of sinus affections merely increases the difficulty of estimating the value of pain as a diagnostic symptom. Pain or tenderness is rarely elicited by pressure upon the facial wall of the antrum. Tenderness induced by pressure on the floor of the frontal sinus in disease of that cavity, or upon the lachrymal bone in ethmoid affections, are signs of clinical value which will be again referred to under special diagnosis.

(*d*) *Certain secondary symptoms* may arise in connection with sinus suppuration, *e.g.* cough, dryness of the throat, and huskiness of voice, due to irritation of the upper air passages from the purulent discharge, while true asthmatic symptoms are occasionally met with. Indigestion is not infrequent as a result of swallowing the offensive secretion.

(*e*) *Eye Symptoms.*—The intimate anatomical association of the various sinuses with the orbit and its contents (Fig. 4), and the proximity of the sphenoidal sinus to the floor of the middle cranial fossa in the neighbourhood of the important oculomotor and optic nerves, sufficiently explain the occasional occurrence of eye symptoms in sinus disease. Generally speaking, we may group these symptoms and signs into two classes: those which are dependent upon displacement of the eyeball by mechanical pressure, such as occurs in ethmoidal, frontal and maxillary suppuration; and, secondly, those which result from compression or destruction of the optic or oculomotor nerves, more commonly met with in sphenoidal sinus disease.

Although an upward and outward displacement of the eyeball may be met with in maxillary sinus suppuration, orbital complications probably arise less frequently in connection with it than with the other cavities. In frontal sinus disease expansion of the bony floor of that cavity, with or without the formation of an orbital abscess, causes swelling at the upper and inner angle of the orbit, and a downward and outward displacement of the globe. A similar displacement is more frequently associated with suppuration in the ethmoid cells in the absence of free drainage from these cells into the nose. The degree of forward projection of the eye (proptosis, exophthalmos) in these affections is mainly dependent upon the relation of the pressure to the equator of the eyeball.

Consequent upon displacement of the eyeball limitations in its movements and disturbances in function follow. Diplopia or double vision, and a narrowing of the field especially for colours, are symptoms met with, while sometimes in severe cases there is an actual impairment of sight, an amblyopia or amaurosis. In association with these phenomena, pain, photophobia, interference with the flow of tears, swelling of the lids, and injection of the conjunctiva, make up a clinical picture which should always suggest the possibility of the existence of accessory sinus suppuration. With the actual formation of pus in the orbital cavity these phenomena become aggravated. Primary orbital abscess is not common, and its occurrence should lead to an examination of the nasal sinuses.

As already indicated, the ocular complications of sphenoidal disease are mainly those resulting from implication of the optic nerve at the base of the skull. Optic neuritis followed by atrophy with partial or complete loss of vision may complicate this condition. If the inflammation should extend and involve the oculomotor nerves in the sphenoidal fissure, ptosis may be produced from implication of the third cranial nerve, while some variety of strabismus or a general paralysis of the ocular muscles may be induced by pressure upon the third, fourth, and sixth nerves. Intense neuralgia may be evidence of a neuritis of the ophthalmic division of the fifth nerve.

It is thus evident that the symptoms complained of by the patient may be varied in cases of chronic suppuration. It is inadvisable, therefore, for the surgeon to hasten to any conclusion without first making a careful examination of the nose. This is all the more necessary when we remember that many of the nasal phenomena above described may be induced by lesions confined to the nasal chambers themselves, and result from such causes as the exanthemata, syphilis, tubercle, atrophic rhinitis, malignant disease, foreign bodies, and naso-pharyngeal catarrh.

(ii.) Examination of the Nose.—On account of the close anatomical relations of the different sinuses and their ostia, the diagnosis of chronic suppuration is often difficult, and is frequently arrived at only by a process of exclusion. We shall therefore endeavour to describe, step by step, the procedure which may be adopted in carrying out a systematic examination of these cavities. Even after a careful inspection of the nose the surgeon may still be in doubt as to the real nature of the case, consequently he should have no hesitation in asking for a subsequent opportunity for further observation. As the intra-nasal appearances vary at different periods of the day, it is advisable that the patient should not be seen on each occasion at the same hour.

Anterior and Posterior Rhinoscopy.—(*a*) *Condition of the Nasal Mucous Membrane.*—In many cases the nasal mucous membrane presents a red and swollen appearance; if the affection is unilateral there is a marked contrast in this respect between the two chambers. The inferior turbinated body is frequently turgescent, preventing inspection of the deeper parts, and necessitating the application to it of cocaine; occasionally the mucosa presents a dry, glazed appearance, associated with some atrophy of the inferior turbinated body. The nostril may be completely blocked by one or more large polypi, so that their removal is, in the first instance, a preliminary to further examination. One or more small polypi confined to the middle meatus are somewhat significant of sinus disease.

(*b*) *The Presence of Pus.*—Pus may be visible upon the inferior turbinated body, on the floor of the nose, or on the septum anteriorly, but the observer's attention must be turned particularly to two situations, namely, the middle meatus and the olfactory cleft. We shall, in the first instance, consider *a case in which pus is observed in the middle meatus* (Figs. 2 and 4). The detection of a drop of pus in this region under cover of the middle turbinated body is highly suggestive of sinus disease, and the sinuses of the anterior group, namely, the maxillary antrum, frontal sinus, and anterior ethmoidal cells should be suspected. The position of the pus in the meatus affords no reliable guide as to which of these cavities is actually its source. If no pus be visible in this situation it must not be at once assumed that there is no further necessity for considering it. We must at once proceed to investigate the case by other means at our disposal.

Posterior rhinoscopy may reveal a purulent discharge in the nasopharynx; it may be detected in the choana of the suspected side, or a favourable examination will disclose a drop of pus on the upper surface of the inferior turbinated body, that is, in the middle meatus posteriorly (Fig. 2). This sign is of considerable value should we fail to detect any secretion in this meatus by anterior rhinoscopy.

Any one of the cavities above mentioned may be affected alone, or any two or all three in combination, hence at the very outset a difficulty in diagnosis is met with. As the maxillary sinus is most frequently the source of the trouble, and as its anatomical position brings it most readily under examination, we proceed in the first place to investigate it.

(iii.) Diagnosis of Chronic Suppuration in the Anterior Group of Sinuses.—A. *The Maxillary Antrum.*—(*a*) *Fränkel's Posture Test.*—It is now necessary to thoroughly remove every trace of pus from the anterior part of the middle meatus. This may be conveniently effected by means of a pledget of cotton wool wrapped round the end of a probe. The patient is then directed to bend his head forwards in such a way that the vertex becomes dependent, while the cheek of the suspected side is at the same time turned uppermost. This position is maintained for two or three minutes: the test sometimes loses its value if the head is not kept sufficiently long in this position. After the head has been raised the middle meatus is again inspected. The reappearance of pus in this situation at once strongly suggests its antral source, and Fränkel's test is spoken of as positive. The position of the ostium maxillare under the roof of the antrum sufficiently explains this phenomenon (Fig. 1). Significant though it is, it is, however, not conclusive. Even in antral suppuration Fränkel's test may prove negative, though at a subsequent examination the reappearance of pus may be noted, a circumstance which may possibly depend upon the quantity of secretion that happens to be in the cavity at the time of inspection. Again, the position of the ostia of the ethmoid bulla and of the middle turbinated cell towards the upper part of their respective cavities will tend to make this test positive in anterior ethmoidal cell suppuration.

Greville Macdonald asserts that, after the head has been dependent, he has found pus reappear in the middle meatus quite as frequently in frontal sinus suppuration. In spite of these possibilities there is no doubt that the posture test when positive is of considerable value in the diagnosis of maxillary suppuration.

(*b*) *The Suction Test.*—Seifert and Réthi have recently advocated the use of the following method in diagnosis:—After all trace of pus has been removed from the nasal chamber, the nozzle of a Politzer's bag already compressed is introduced into the nostril of the suspected side; the anterior nares are closed, and, when the patient is directed to swallow, the bag is allowed to suddenly expand. The object of this manœuvre is to withdraw by suction some of the secretion from the sinuses. The nose is again inspected and pus sought for in the middle meatus. Should it be visible in that situation its sinus origin is suggested, but there still remains the difficulty of definitely tracing it to one or other of the ostia situated in that channel.

(*c*) *The Illumination Test.*—A knowledge of the fact first demonstrated by Voltolini and later developed by Heryng, that luminous electric rays can be transmitted through the bony walls of many healthy maxillary sinuses, has furnished us with a diagnostic aid of considerable value. In order to effect this the following method is adopted:—Should the patient wear a dental plate, he is directed in the first instance to remove it; the room is then darkened, or the patient's head and shoulders, along with those of the observer, are enveloped in a black cloth, great care being taken to exclude every source of extraneous light. A small electric 8-volt lamp of about 1 ampère current is employed. This is fitted to a special tongue-depressor, which is provided with a detachable vulcanite plate. The electrical current can be obtained from a suitable accumulator. The tongue-depressor is placed in the centre of the mouth and the patient's lips are closed upon its stem. He is then directed to close his eyes. Contact is made by pressure upon a button in the handle of the spatula. Three phenomena of illumination may be met with. The rays of light traversing the maxillary cavities may become visible to the observer on the cheeks of the patient as a small *crescent-shaped zone of light situated immediately below each eye.* This illuminated area varies in size and in intensity, but it indicates that the rays have penetrated the cavity. In most cases the light is transmitted through the soft tissues of the cheek, producing a considerable area of illumination, which, however, must not be taken into consideration. The rays as they pass through the roof of the antrum and the coats of the eyeballs are thrown upon the retinæ, and are perceived by the patient as a subjective light sensation; this phenomenon was first pointed out by Brown Kelly. It is also possible in many cases, after the patient has been directed to open his eyes, for the observer on looking through the pupils to see the light reflection. A comparison of the results obtained on the two sides is then made. While variations in the intensity of the illumination on the two sides are met with, it is not common to find in *healthy* antra complete opacity on one side associated with a bright area of illumination upon the other. If illumination is negative, it occurs more frequently on both sides. The subjective sensation of light and the pupil reflection also vary to some extent in health, and the latter test is perhaps better left out of account. When the mucous membrane of the antrum is inflamed and the cavity contains pus, or when it is occupied by a solid growth, the luminous rays as a rule either do not pass through it at all or only to a very slight extent. When there is cystic dilatation of the antrum, on the other hand, the illumination is intensified. In unilateral inflammatory affections of the antrum, therefore, illumination of the diseased side does not as a rule occur, so that a distinct contrast with the opposite healthy side is obtained. When both antra are affected so that no comparison is thereby possible, the test loses its value, and we must further remember that opacity of both cheeks may be due to a normal anatomical condition of the parts. As the result of a large number of observations, I am led to conclude that in the majority of cases of antral disease the affected sinus fails to illuminate. This is evidenced by the complete opacity of the infra-orbital region of that side, and by the inability of the patient to detect any subjective light sensation. Sometimes there is a faint illumination upon the suspected side, along with some degree of light perception, but the former still distinctly contrasts with the opposite healthy side. Occasionally, but in my experience rarely, a case is met with in which the affected sinus illuminates like its healthy neighbour.

When opacity of the cheek is associated with pus in the middle meatus, which reappears after Fränkel's posture test, there is sufficient presumptive evidence of disease in the corresponding antral cavity, and exploratory puncture of the sinus is not necessary. There is, however, a second but small group of cases in which the suspected antrum is opaque, and where the opposite presumably healthy cavity only faintly illuminates, so that there is no distinct contrast. Such a case must suggest the possibility that there may be some anatomical reason for the opacity—both sides being so much alike—so that in such a case illumination is not of the same assistance, and an exploratory puncture is desirable.

In cases of chronic suppuration non-illumination is due more to the inflammation and thickening of the mucous lining than to the presence of pus in the cavity. This is shown by the fact that after a quantity of pus has been washed out of the antrum, and the test repeated, opacity remains. For the same reason the thickness of the pus bears no relation to the density of the shadow produced. It has been suggested that in those cases in which the antrum merely serves as a reservoir for pus secreted in the frontal sinus, opacity of the cheek is less pronounced than when it is actually secreted in the antrum itself. I have been unable to satisfy myself of this, and am inclined to think that an antrum cannot remain merely a reservoir for long, but must soon become actually infected. Illumination further assists us in arriving at a knowledge of the progress of the case towards recovery. When a diseased cavity, previously opaque, again illuminates, we have evidence of the restoration of its lining membrane towards a more normal condition. At the same time its failure to illuminate must not be taken to imply that a cure has not resulted. Regnier and Glover have suggested the use of the X rays for testing the transparency of the maxillary sinuses. Until this method of research is brought more within the reach of the clinician it is not likely to supersede the illumination above described.

If the various features of the case already enumerated, when studied together, still fail to convince the observer that the antrum is affected, he must proceed through an exploratory puncture to inflate or syringe out the cavity. The presence of pus in the middle meatus, associated with some degree of fœtor and bad taste, and the existence of one or more carious teeth, is suggestive of antral suppuration. If, further, discharge reappears after stooping, and the cheek of the suspected side is opaque, the evidence is strongly presumptive. It is, however, only conclusive when pus is blown or washed out of the cavity.

Before proceeding to carry this out the nasal chamber, including the middle meatus, must be carefully cleansed of every trace of pus by means of cotton wool mops, or by syringing. This cannot be too strongly insisted upon, otherwise the test loses its value. If the lotion injected through the maxillary sinus passes thence through a nasal cavity which has not been thoroughly cleaned, there is no guarantee that the discharge washed out was not secreted in the frontal sinus or anterior ethmoidal cells. This fallacy is avoided by preliminary cleansing of the nose. One of the following methods of puncture may be employed:—

(*d*) *Exploration through the Outer Wall of the Inferior Meatus of the Nose.*—This is, as a rule, a simple procedure, and is the most serviceable in doubtful cases, because in the event of the cavity proving to be healthy no inconvenience results such as might follow a temporary opening through a septic cavity like the mouth. The area selected lies immediately below the attachment of the anterior end of the inferior turbinated body where the bone is thinnest (Fig. 4). That structure and the mucous membrane of the outer wall of the inferior meatus are cocainised. If the turbinated body be turgescent, and tend to obscure the wall beneath it, the cocaine will reduce the swelling. A fine Lichtwitz's trocar and cannula, a Krause's or a Sprenger's trocar, is then introduced through a Thudichum's nasal speculum, the instrument being guided by the eye with the aid of good illumination. The trocar should be directed outwards and upwards; a firm push may be necessary before the wall is perforated and the cavity entered. The sensation of passing through bone, the somewhat sudden release of the point of the instrument and its mobility, will testify to its presence in the sinus. Occasionally a case is met with in which the bone offers so much resistance that some other route must be adopted. It is rare to find pus flow outwards through the cannula, so that the condition of the cavity must be investigated by the inflation of air or by washing out. For the purpose of inflation a piece of india-rubber tubing, to which a Politzer's bag is attached, is passed over the outer end of the cannula. The operator's left hand holds the nasal speculum and instrument, while with the right the bag is compressed. The middle meatus is carefully inspected during the act, and the secretion looked for in it. In order to wash out the sinus, a Higginson's syringe with a fine nozzle is attached to the cannula, and a warm boracic or warm sterilised salt solution is gently injected. During this procedure the patient should lean slightly forwards over an empty basin, and as the stream of fluid passing through the natural orifice of the antrum flows from the nasal cavity into the basin, it is examined for the detection of abnormal secretion.

(*e*) *Exploration through the Natural Opening or Ostium Maxillare.*—The introduction of a suitably curved cannula through the hiatus semilunaris into the orifice of the antrum, while recommended by some operators for diagnostic purposes, is by no means an easy procedure. The concealed position of the orifice renders this difficult, and when the mucous membrane is swollen, and small polypi surround the hiatus, the operation is rendered still more difficult. A Hartmann's curved cannula is recommended for this purpose.

(*f*) *Exploration through the Socket of a Carious Tooth.*—This procedure is a therapeutic as well as a diagnostic one. When there still exists some doubt as to the exact condition of the maxillary sinus, the socket of a diseased tooth—which is first extracted—in relation to the floor of the sinus may be drilled and the cavity washed out (Fig. 1). Should pus be present a suitable plug can then be adapted, as will be described under treatment.

(*g*) *Exploration through the Canine Fossa.*—For diagnostic purposes only this route is rarely employed. Should the examiner feel tolerably certain that he is dealing with antral suppuration, and in the event of the patient possessing a complete and sound set of teeth, a somewhat rare distinction, an opening may be made in this situation. This will serve to confirm the diagnosis, and at the same time provide a channel for the treatment of the diseased sinus.

By adopting the above routine practice the surgeon will probably have convinced himself of the existence of chronic antral suppuration, or, on the other hand, have satisfied himself that the cavity is healthy. If he has failed to do so at the first sitting a second or a third examination may have proved more satisfactory. By establishing this diagnosis he has probably not excluded, however, the possibility of a coexisting frontal sinus or anterior ethmoidal cell suppuration. Although the antrum in a great number of cases is alone diseased, we know how frequently two or more of these cavities are affected in combination. When a considerable quantity of pus is observed in the nose, and only a scanty amount is washed out of the maxillary sinus, the suspicion of some further sinus mischief should be aroused. In some cases a diagnosis of frontal or ethmoidal suppuration is only made after the antrum has been for some time under treatment. If the examination has demonstrated the fact that the antrum is healthy, or if pus still flows into the middle meatus after that cavity has been washed out, it is necessary to proceed to a further investigation of the nose.

B. *Diagnosis of Chronic Suppuration in the Frontal Sinus.*—Under general symptomatology certain points were referred to which suggested that the source of the pus might be in the frontal sinus. Amongst these were noted its greenish colour and the absence of fœtor; further, the more continuous flow of the discharge, its situation high up and anteriorly in the nose, and its non-appearance after the head has been bent forwards, were also commented upon. The frequent combination of sinus affections, the close anatomical association of the various ostia, and the frequent changes in the position of the patient's head, must necessarily make these signs of little diagnostic value, even should all of them coexist.

(*a*) *Reappearance of Pus in the Middle Meatus after Syringing the Antrum.*—After the antrum has been syringed, and the middle meatus carefully cleansed of every trace of pus, the patient should be directed to sit quietly for ten or fifteen minutes without inclining his head forwards even to a slight degree. At the end of this interval the nose is again examined, and if a drop of pus be observed in the middle meatus a suspicion of its origin in the frontal sinus is raised. The position of the ostium maxillare makes it impossible for secretion from that cavity to pass out into the nose in so short a space of time. This observation is assisted by the previous insertion of a wool tampon against the lower and posterior part of the hiatus semilunaris as recommended by Grünwald, so that the possible escape of secretion from the antrum is thus hindered. This test, however, does not exclude the possibility of some ethmoidal cell suppuration which is so frequently present along with frontal sinus disease.

(*b*) *Tenderness on Pressure upon the Floor of the Frontal Sinus.*—In applying this test pressure must be made with the finger upon the thin bony floor of the sinus beneath the inner third of the supra-orbital margin. Care must be taken to avoid the supra-orbital nerve lying somewhat externally; and, further, pressure must not be made on the bony margin of the orbit. It is a good plan to apply the test simultaneously upon both sides, the patient being asked to press down upon the fingers. A more equal distribution of pressure and a more accurate observation are thus obtained. It is very necessary to differentiate between a surface soreness, such as is elicited even in healthy individuals, and the more deeply-seated true pain. In many cases the patient readily admits the existence of this tenderness, and considerable reliance may be placed upon this sign as an aid in diagnosis when taken in conjunction with other phenomena; on the other hand, the patient's statement cannot always be relied upon. Percussion of or firm pressure upon the thicker anterior sinus wall may fail altogether to elicit tenderness over an affected cavity.

(*c*) *Redness, Œdema, or Swelling in the Region of the Sinus.*—Although these signs are more frequently evidence of an acute exacerbation, possibly resulting from an unusual retention of discharge, they may occur as transient phenomena in chronic cases. Careful observation and palpation may detect some slight degree of œdema or thickening upon the lower part of the forehead or in the upper eyelid. The patient may volunteer the statement that he has observed temporary swelling in this region. It has been stated that, after percussion over both sinuses, the redness of the skin thus produced remains for a longer period over an affected cavity than upon the healthy side, a point upon which I have never been able to satisfy myself.

(*d*) *Trans-illumination of the Frontal Sinus.*—The same lamp is used as in antral illumination, but the vulcanite plate is removed and a short tube of metal, vulcanite, india-rubber, bone, or ivory—the two latter being carefully blackened—is passed over the globe of the lamp. In this way the light is transmitted in one direction only, that is, through the open end of the funnel, which should project somewhat beyond the lamp. The room is darkened, or the head and shoulders of the patient and observer are covered as before, and the end of the funnel having a direction upwards, inwards, and slightly backwards, is placed against the skin covering the floor of the sinus, beneath the inner third of the supra-orbital margin; great care should be taken to see that the edge of the funnel lies well beneath the bony margin of the orbit. When contact is made an illuminated area indicating the frontal sinus of that side may be observed upon the lower part of the forehead. The same manipulation is then repeated upon the opposite side and the result noted. The junction between light and darkness indicates the position of the intervening septum. The intensity of the light and the area of its distribution varies in different skulls, and frequently upon the two sides of the same skull. A comparison of the two results obtained must be made and noted. It is also possible to illuminate both sinuses simultaneously by transmitting the light through two tubes as practised by Lubet-Barbon and Furet. The frontal sinuses cannot be illuminated by the mouth as has been suggested in some text-books. The diagnostic value of this test has been much discussed. Both on anatomical and clinical grounds I find it practically of no value in diagnosis. In my experience a diseased frontal sinus will illuminate just as brightly as its healthy neighbour.

So far, therefore, in the diagnosis of frontal sinus suppuration we have to rely upon the exclusion of antral disease and upon the reappearance of pus in the middle meatus of the nose, shortly after syringing out the latter cavity when it is affected. As this latter sign is consistent with suppuration in the anterior ethmoidal cells, we must endeavour to elicit tenderness on pressure upon the floor of the frontal sinus, and investigate the occurrence of œdema or redness of the skin of the forehead and upper eyelid. While all these signs furnish suggestive and even presumptive evidence of the disease, it is necessary to catheterise the sinus before establishing a diagnosis with any degree of certainty.

(*e*) *Probing and Catheterisation through the Ostium Frontale.*—Although probing the sinus cannot be carried out in a number of cases there is a large proportion in which this can be accomplished with considerable ease. Two anatomical difficulties, however, may present themselves: in the first place, there is a difficulty due to the presence of the middle turbinated body, and the narrowing and sometimes irregular course of the infundibulum; and, secondly, there is the risk of the instrument entering one of the anterior ethmoidal cells. The fact that such a cell may reach a considerably higher level than that of the floor of the frontal sinus only increases the difficulty of accurately estimating the exact position of the point of the instrument. The difficulties may be increased by such pathological conditions as polypi or hypertrophy of the mucous membrane. Should the attempt to enter the sinus fail, then the anterior portion of the middle turbinated bone must be removed (see "Treatment," p. 440). The operation is not a difficult one, and possesses the double advantage of first securing better access to, and later of ensuring better drainage from the sinus (Fig. 2). A day or two after the removal of that bone, and after cocainising the nose and thoroughly removing every trace of pus, a long fine silver probe is introduced through a Thudichum's speculum, its point being guided by the eye with the aid of good illumination. The proximal end of the probe must be bent downwards so that the operator's hand does not obstruct his line of vision; at the distal end of the instrument a curve 3 cms. in length is made, forming an angle of about 135° with the shaft. It may be found necessary to vary this curve slightly in different cases, so that its angle cannot always be stated with mathematical accuracy. Sometimes, too, it may be necessary to bend the extremity somewhat in a lateral direction. As in the majority of cases fewer ethmoidal openings lie on the inner or septal aspect of the fronto-nasal duct, it is advisable to keep the point of the probe towards the mesial plane, and even in contact with the outer surface of the upper portion of that part of the middle turbinated body which has not been previously removed. No force must be employed, but the instrument gently insinuated upwards and forwards until a sense of resistance makes further entrance impossible. The probe should then be grasped between the finger and thumb where the upper lip joins the nostril, and gently withdrawn. During its withdrawal the fronto-nasal region must be carefully examined, and the reappearance of pus in the track of the probe noted. The portion of the probe which has been inserted is then laid against the outside of the nose, and the position of its point located externally. If, when held in this position, the point of the instrument is found to reach above the supra-orbital margin, it may be justly assumed that it had previously entered the frontal sinus. The distance of the floor of the frontal sinus from the anterior naris has been estimated by Hansberg as 60 mm. (6 cms.), while Cholewa found it to be 70 mm. In some cases, however, there remains a feeling of doubt as to whether the probe has really entered the frontal sinus or one of the anterior ethmoid cells grouped round the floor of the sinus. The Röntgen rays have been successfully employed in locating the end of the probe within the frontal sinus.

The probe test should next be supplemented by the introduction of a frontal cannula. For this purpose Hartmann's may be used. I have found the pattern introduced by Brown Kelly of Glasgow very satisfactory, and fulfilling all the necessary requirements. To the proximal end of the catheter a piece of rubber tubing and a Politzer's bag are attached; inflation is then carried out during careful inspection of the interior of the nose. Pus mixed with air may then be seen to be driven downwards. Gentle syringing of the cavity may be substituted, and pus looked for in the lotion.

The frequency of an associated frontal and ethmoidal suppuration undoubtedly increases the difficulty of diagnosing the existence of the former. If a considerable quantity of pus be expelled by inflation or syringing, suspicion of an affection of the larger cavity will be raised, but it may be necessary to treat the ethmoid condition before it is possible to recognise that pus is coming from a higher source. There still remain some cases in which, in the present state of our knowledge, an external opening into the frontal sinus is necessary before an exact diagnosis can be arrived at. We must duly weigh all the clinical phenomena taken together, and not seek to draw a conclusion for or against frontal sinus suppuration from this or that individual sign.

C. *Diagnosis of Chronic Suppuration in the Anterior Ethmoidal Cells.*—

We have already drawn attention to the fact that suppuration in the frontal sinus is very frequently associated with the same affection in the anterior ethmoidal cells. Similarly, the latter cells may also be affected in association with maxillary sinus disease though by no means with the same frequency. It may not be possible, therefore, to accurately establish the diagnosis of ethmoid cell suppuration without first satisfying ourselves as to the condition of these other cavities. Hence a diagnosis may be arrived at by a process of exclusion.

The examination of the ethmoid region will be greatly facilitated by the removal of the greater portion of the middle turbinated bone, if this has not been already done when exploring the frontal sinus. If this bone should contain an air-cell the latter may be found to contain pus, while its lining membrane may be swollen and thickened. The field of observation is thus considerably enlarged, and a number of small polypi with pus oozing from between them may then be detected. If a fine probe, with its extremity bent somewhat outwards, be pushed upwards between these polypi in the direction of the ethmoid cells, an increased flow of purulent secretion may be observed to follow this manœuvre. It has been asserted that the probe thus introduced comes in contact with granulation tissue and areas of carious bone. It must be borne in mind, however, that it is very difficult in this situation to conclude from the sense of touch whether the bone is actually carious, and whether the probe is in a cavity lined with granulations or with a healthy mucous membrane. After completing this part of the examination the polypi should be removed, and on a subsequent occasion the nose should again be carefully inspected and the source of the pus sought for. If the formation of the nasal chamber permit the examiner to localise the position of the hiatus semilunaris and bulla ethmoidalis, he should proceed to occlude the former by means of a cotton-wool tampon. The nose is then cleaned, and an attempt is made with a probe or cannula to enter the ethmoid cells lying above the bulla by passing the instrument upwards and outwards. Inflation through the catheter may be followed by the blowing of pus into the middle meatus. If the ethmoidal cells situated more anteriorly and opening into the upper end of the infundibulum are catheterised, some doubt will naturally arise as to whether pus blown down from this region has actually been secreted in these cells or has trickled down from the frontal sinus at a higher level. By repeated observation, by the removal of small polypi and portions of the bony framework of the lateral mass of the ethmoid, the source of the pus is thus gradually followed up and ascertained. This procedure not only leads to a diagnosis of the true condition, but forms in a large measure the preliminary stages of treatment.

(iv.) DIAGNOSIS OF CHRONIC SUPPURATION IN THE POSTERIOR GROUP OF SINUSES—*The Sphenoidal Sinus and Posterior Ethmoidal Cells.*—We have thus far endeavoured to trace the source of the suppuration in those cases in which anterior rhinoscopy has revealed the presence of pus in the middle meatus, and in which on posterior rhinoscopy pus has been detected upon the upper surface of the posterior extremity of the inferior turbinated body. A diagnosis of maxillary, frontal, or anterior ethmoidal cell suppuration has probably been established. Let us now assume that we have to deal with a patient in whom, on anterior rhinoscopy, the middle meatus is found free from pus, but *purulent discharge is seen to lie in the olfactory cleft* between the middle turbinate body and the septum nasi (Fig. 4). Suspicion is then directed to the posterior group of sinuses, the posterior ethmoidal cells, and the sphenoidal sinus. The similarity of the nasal phenomena which may be presented by each, and the fact that their close proximity renders them liable to be affected at the same time, makes a differential diagnosis sometimes difficult. We are therefore led to consider these air spaces together. The clinical differentiation into two groups is not always so simple as the anatomical basis would indicate, as pus from the posterior ethmoidal cells may find its way into the middle meatus. Again, owing to the position of the ostia of the posterior group there is a greater tendency for the secretion to pass backwards into the naso-pharynx, and thus leave the interior of the nose more or less free. It must not be assumed, therefore, that in the absence of pus in the olfactory cleft there is no affection of the posterior group of sinuses. If the disease should coexist in one or more sinuses of both groups the diagnosis is still further complicated. It may only be after excluding or treating disease in the anterior sinuses that we are led to suspect its existence in the posterior ethmoidal or sphenoidal cavities. Our knowledge of chronic suppuration in the latter cavity is largely due to the observations of Grünwald and Hajek.

(*a*) *Anterior rhinoscopy.*—When *pus* is observed in the olfactory cleft it should be carefully mopped out with cotton-wool pledgets and the region again inspected. If more secretion becomes visible, suspicion is aroused of its probable source in the posterior ethmoidal or sphenoidal cells. The removal of a crust in the same locality followed by a discharge of pus is also significant. Sometimes the olfactory fissure is occluded by swelling of the mucous membrane and no pus is visible. If, under these circumstances, a purulent discharge follows the forcible introduction and withdrawal of a probe protected with a cotton-wool tampon the same inference is drawn.

Polypi are not frequently met with in this situation, although their occurrence has been described.

(*b*) *Posterior rhinoscopy* plays a somewhat more important part in the examination of these cases. Owing to the situation of the posterior ostia, pus tends to pass backwards into the naso-pharynx rather than forwards into the nose. Inspection of the vault probably reveals the presence of one or more crusts adherent to the mucous membrane. Intermixed with the crusts some fluid secretion may also be visible. In these cases a careful examination of the choanæ must be made, because the presence of pus within one or other of these apertures is always very suggestive of the origin of the secretion in an accessory cavity. Should the discharge at the same time be visible upon the upper surface of the middle turbinate body, *i.e.*, in the superior meatus, it is still more suggestive (Fig. 2). When it occurs in this latter situation the source of the pus from one of the sinuses of the anterior group is excluded on anatomical grounds. If it is difficult to obtain a thorough inspection of the naso-pharynx, cocaine should be applied and the palate-hook placed in position. The clinical picture presented by some of these cases is not unlike what is met with in that form of naso-pharyngeal catarrh which is associated with crust formation. Many cases are unsuccessfully treated as such for a considerable length of time. Hence it is very important for diagnostic reasons to detect the presence of pus within the posterior naris and upon the middle turbinate body. It should be made a routine practice in all cases of naso-pharyngeal catarrh to inspect and probe the interior of the nose, keeping in mind the possibility of a sinus affection.

(*c*) *Ophthalmoscopic examination* will prove of value in some instances. The eye changes that may be met with have already been referred to (p. 422).

While the above signs are suggestive of suppuration in the posterior group of sinuses, it is as necessary here as in the case of the anterior group to accurately locate the source of origin of the pus. To effect this the middle turbinated bone should be removed in order to expose the anterior wall of the sphenoidal cavity. It is probable that in some cases this has already been partly done, where disease of the anterior ethmoidal or frontal sinuses has either been suspected or has actually been found to exist. It is true that cases are occasionally met with where a wide olfactory cleft permits of inspection of the sphenoidal orifice by anterior rhinoscopy, but such cases are extremely rare. Moreover, in some instances the superior turbinated body interferes with direct inspection of that opening, which is subject to variation in its position. The whole of the middle turbinated bone should therefore be removed (p. 440).

(c) *Inspection, Probing, and Catheterisation of the Ostium Sphenoidale.*—After an interval of two or three days the nose should again be inspected by anterior rhinoscopy, and all traces of crusts and purulent discharge in the post-nasal region thoroughly removed. This procedure demands the same care as it did in the case of examination of the maxillary and frontal sinuses. The sphenoidal opening may then become visible (Fig. 2). Should pus be seen issuing from it the diagnosis is established. Should no discharge be visible a cotton-wool tampon must be packed against the ostium and left in position for half an hour. On its removal the presence of pus on the deep surface of the wool will testify to its origin in the sphenoidal cavity. The introduction of a sphenoidal sinus cannula made after Grünwald's pattern, followed by inflation or syringing of the cavity, will furnish further proof of the presence of a chronic suppuration. It is recommended that a probe should next be introduced, and an attempt made to ascertain the condition of the walls of the cavity. Great care should attend this manipulation, especially when the roof of the cavity is under examination. As the sinus varies considerably in size in different skulls it is impossible to form an accurate estimate of the distance to which the probe may be passed.

If on anatomical grounds it is impossible to see the sphenoidal orifice by direct inspection, some authors advocate and practise perforation of the anterior wall of the sinus with a sharp instrument. Thus Schäffer has employed a spoon probe, while Spiess recommends an electro-motor trephine. This operation, however, demands the greatest care, and should not be undertaken without due regard to its possible dangers.

Attention should next be turned to the diagnosis of suppuration in the posterior ethmoidal cells, whether occurring alone or in conjunction with suppuration in the sphenoidal cavity. The sphenoidal orifice should be plugged with a cotton-wool tampon after careful cleansing of its vicinity. If pus then collects in the nose anteriorly to the plug, or even stains the nasal surface of the wool, a suspicion of ethmoidal disease is raised. A probe with its point bent outwards should then be passed in the direction of these cells, and an attempt made to further investigate their condition.

7. TREATMENT OF CHRONIC SUPPURATION IN THE ACCESSORY SINUSES

In considering the treatment of chronic suppuration we must be guided by general surgical principles, and endeavour to determine in each case what pathological conditions are present and how they may be most satisfactorily dealt with. In all cases in which nasal polypi and hypertrophies of the mucous membrane exist they must be removed, so that partial occlusion of the natural orifices is got rid of, and freer drainage thus established. In the case of the antrum diseased teeth should be extracted, whether they can be definitely proved to be the causal factor or not. When there is a polypoid condition of the lining membrane of the sinus, or when there is caries of its osseous walls, steps must be taken to deal with these conditions. The frequency of associated sinus mischief must be borne in mind, and the possibility that the sinus under treatment may be reinfected by pus, which is being secreted in one of the other cavities must not be lost sight of. Until these points are elucidated and dealt with all the conditions of successful treatment cannot be fulfilled.

A. *Treatment of Chronic Suppuration in the Maxillary Antrum.*—In the treatment of chronic suppuration of this sinus one of two courses may be adopted: either to open the sinus through the socket of a tooth, and regularly wash it out for a varying period of time, or to perform a radical operation. Some difference of opinion exists regarding the choice of operation in every case. There are undoubtedly a number of cases in which a course of irrigation suffices to effect a cure, though no definite statement can be made as to the length of time necessary to bring this about. There are other cases, again, which from the first are doomed to failure by this method, but unfortunately we are not always able to say which these cases are. When the lining membrane of the antrum has been converted into polypoid tissue only the radical operation will prove successful; when such changes have not taken place a reasonable trial should be given to the simpler line of treatment. It is difficult, if not impossible, to say what the condition of the mucosa is unless one first opens into the sinus to see, and the ordinary alveolar opening does not permit of inspection of the cavity. The duration of the affection does not altogether help us, as cavities which have discharged pus for some years are sometimes cured under simple lavage, while those of more recent origin may fail to be so. I have not found trans-illumination of any material assistance on this point; the density of the opacity does not guide us as to the exact condition of the lining membrane. In uncomplicated antral cases, therefore, if there is no reason to believe that any of the other sinuses on the same side of the nose are affected, the irrigation treatment should be given a fair trial. If, however, associated ethmoidal or frontal sinus suppuration exist more radical methods should be resorted to from the first. A number of satisfactory results will encourage the surgeon to advocate treatment by lavage. The operation appeals to the patient, to whom, however, the possibility of failure and the necessity for further treatment should be explained. It can be readily performed under nitrous oxide anæsthesia, and it does not confine the patient to the house, while the after treatment can be carried out quite independently of the medical attendant. At the same time, in a fair proportion of cases this method proves a failure, and after a tiresome course of syringing, and perhaps at considerable inconvenience to himself, the patient must submit to the radical operation.

(i.) *Treatment by Lavage.*—In all cases in which nasal polypi and hypertrophies are present they must, in the first instance, be removed, so that there may be no interference with the free escape of the lotion through the natural antral orifice. For purposes of irrigation two routes are open to us, the nasal and the buccal. It is hardly necessary to do more than merely refer to irrigation through the nose. The natural orifice of the antrum may be at once dismissed, as it is impracticable for the patient and usually so for the surgeon. An opening made through the outer wall of the inferior meatus of the nose below the anterior end of the inferior turbinated bone finds favour with some who have successfully practised it. It certainly has the advantage of not being connected with a septic cavity like the mouth; on the other hand, the patient often has a difficulty in finding the opening, which further has a tendency to rapidly close. It may be mentioned in passing that a cure has, in one or two cases, been reported following upon a single puncture of the nasal wall and irrigation of the cavity.

The Alveolar Opening.—This certainly forms the most convenient route, and the one most frequently selected. By adopting this method two important requirements are at once met, namely, the removal of a diseased tooth—the possible causative factor—and the opening of the cavity at its most dependent part (Fig. 1). The disadvantage lies in establishing a communication with the mouth; this may be, however, largely counterbalanced by inserting a solid plug into the aperture instead of the open drainage tube formerly employed.

The operation can be performed under nitrous oxide gas, bromide of ethyl, or chloroform anæsthesia. The first or second molar tooth, if diseased, should be extracted, the socket pierced by one of the numerous forms of antral perforator, and the cavity entered. It is well to emphasise the fact that too small a hole must not be made through the alveolus. The teeth underlying the affected antrum should be thoroughly inspected, and where disease is detected either careful stopping or removal should be insisted upon, as it is foolish to attempt treatment of the sinus while carious teeth still remain in the jaw. Should a suitable gap exist between sound teeth it may be utilised for a similar purpose.

The cavity is next washed out with a warm sterilised or weak antiseptic solution, and a solid obturator is prepared for insertion. As our primary object is rather to maintain the opening thus made, so that syringing may be regularly carried out, and not to establish a dependent drain, it is better to employ a solid plug instead of an open drainage tube. In the latter case the patient is annoyed with the dribbling of pus into the mouth, while there is always an open track for fresh infection from that source, and for the introduction of food particles. To obviate this latter risk, some operators who use the open drain recommend plugging of the tube during meals. If, however, the sinus be systematically syringed, any disadvantage which might accrue from a temporary accumulation of pus within it, is certainly less than the annoyance and risk of a tube which is always open. An obturator made of vulcanite, caoutchouc, or silver gilt proves very serviceable; the proper length of the plug is ascertained by measuring with a probe bent at its point the depth of the track which has been made in the alveolus. Obviously it is very necessary to have this securely fastened in position, so that it may neither slip into the cavity nor drop into the mouth. Various methods are employed for this purpose. If the patient already wear a dental plate the plug may be attached to it, the wound in the alveolus being temporarily plugged with gauze while this is being prepared. Its attachment may be made to a neighbouring tooth by some form of ring, or in the absence of teeth a plate should be moulded to the jaw. Many of these points are best attended to by the dentist. If all the teeth are present and perfectly sound—a state of things not very frequently met with in these cases—a healthy tooth should not be sacrificed. The sinus may then be opened through the canine fossa, care being taken after perforating the bone to securely fix the plug in that opening. If, however, this method has to be adopted, I am in favour of making a fairly large opening in that fossa, inspecting the interior through it, curetting the lining membrane if necessary, and packing the sinus with gauze or worsted, in other words, performing the radical operation.

The patient should be carefully instructed with regard to the method of syringing the cavity; some form of ball syringe, or the ordinary soft rubber Higginson syringe, to which a narrow nozzle has been adapted, will suit the purpose. Various non-irritating lotions are recommended: a warm salt solution (ʒj.-Oj.), a warm boracic or an alkaline lotion may be employed; a mild astringent, such as sulphate of zinc (grs. 2-℥j.), is sometimes used at a later stage. Protargol has been highly recommended by Alexander of Berlin; he introduces daily 50 cc. of a 5 per cent. solution after syringing the cavity with sterilised water. A change of lotion is sometimes beneficial when healing is delayed. The plug having been removed, the nozzle of the syringe is introduced into the alveolar opening, and the patient, inclining his head forwards so that the lotion may flow outwards through the anterior naris, gently syringes the cavity. It is important to bear in mind that forcible syringing must be avoided; I feel certain that with the head inclined forwards, infection of the anterior ethmoidal cells, or even of the frontal sinus, may and does sometimes occur as the result of too vigorous syringing. If the antrum be filled with water experimentally, and the head tilted forwards, some of the fluid is observed to flow readily along the infundibulum and fronto-nasal passage into the frontal sinus. Blocking of the hiatus semilunaris from polypi, or a swollen condition of its mucosa, would still further facilitate this. At the commencement of treatment the cavity should be syringed out twice or even three times daily, if the discharge is profuse and fœtid. Later, as it gradually diminishes in quantity and the symptoms disappear, irrigation is carried out with less frequency, until a week elapses without syringing. If the lotion then passes through the cavity in a perfectly clear stream, and if at the end of a second and third week the same result is again noted, it may be considered safe to remove the plug and allow the track to close. Occasionally one finds that a minimum of discharge will cease altogether by discontinuing the irrigation which has really tended to maintain a slight catarrh of the mucous membrane. The alveolar opening, as a rule, readily closes; the obturator should be shortened so that the upper part of the track may first close before the plug is finally removed.

The time required to obtain so desirable a result varies from a few weeks to several months. The question naturally arises as to the length of the period which is necessary to continue lavage in those cases which do not readily respond to treatment. It is impossible to estimate this from the point of view of time; more reliable information is to be obtained by carefully observing the amount and the character of the discharge, especially the latter. If, after lavage has been regularly carried out for three or four months, there still remains a definite quantity of thickish pus or muco-pus, unaffected by a change of lotion, the question of further treatment should be considered. If there is no intra-nasal disease, and no evidence of suppuration in any of the other cavities which may be adversely influencing the antrum, and the patient expresses himself as weary of the constant irrigation, the surgeon may then reasonably decide upon more radical measures.

(ii.) *The Radical Operation.*—This consists in opening into the sinus, curetting its altered mucous lining, and dealing with carious or necrosed bone, should such be found, and then by appropriate after-treatment encouraging the formation of a new lining membrane. It is mainly in this way, though to some extent also by the filling up of the cavity with granulation tissue and its subsequent organisation, that an antrum thus treated heals. It is unfortunate, perhaps, that obliteration of the cavity is not possible. During recent years various procedures—some of which are merely old methods reintroduced—have been carried out with the object of putting the above principles into effect.

Opening through the Canine Fossa.—This operation is greatly facilitated by administering the chloroform from a Junker's inhaler through a metal tube, the end of which is passed into the nose or mouth; in this way the operator's view is not interfered with, and the patient can be kept more continuously under the influence of the anæsthetic. It is advisable also to insert a gag between the teeth on the side opposite to the diseased antrum, and to have a number of throat sponges prepared for immediate use. A sponge fixed on a holder should be introduced between the cheek and the molar teeth on the same side as the disease; if this be frequently changed, it will be found of great assistance in preventing the blood from passing into the throat. The operator should also provide himself with long strips of gauze for the purpose of controlling the hæmorrhage in the antral cavity. The operation should be conducted with every antiseptic precaution. The upper lip having been everted, an incision is made down to the bone through the fold of mucous membrane between the lip and the alveolus; this incision is carried from the canine ridge outwards to the malar process of the superior maxilla. The periosteum is then raised and retracted so that the whole area of bone forming the canine fossa is thoroughly exposed. With the aid of a chisel and mallet, a perforator, or a small trephine saw, the antral cavity is then entered. The opening may be enlarged by means of bone forceps, Zaufal's mastoid forceps being very useful for this purpose, or by electro-motor burs which are also very serviceable for smoothing the bony edges of the opening. While reflecting the periosteum and removing the facial wall in an upward direction, care must be taken not to injure the infra-orbital nerve and artery as they pass through the foramen of that name at a varying distance beneath the infra-orbital margin. The size of the opening made in the bone varies; some operators enlarge it so that the interior of the cavity may be carefully inspected and the little finger readily inserted in order to palpate the walls in every direction. Others, again, content themselves with a smaller opening: the larger one, however, is certainly to be preferred. Hæmorrhage is controlled and the cavity dried out by plugging; at this stage of the operation good illumination reflected from a mirror or obtained from an electric forehead lamp is essential for a thorough inspection of the interior of the sinus.

The altered mucous membrane is then scraped with a sharp spoon; it is very necessary that the different walls and angles of the cavity should come within the reach of the curette so that no focus of disease is overlooked, a step which has a very important influence on the success of the operation. Special attention should be paid to the floor and the malar region. For this purpose sharp spoons or ring knives which can be fixed at different angles should be employed. I find the latter, mounted on a pliable stem which can be bent by the operator to suit each case, of great use. The hæmorrhage, which is usually pretty free at this stage, should again be controlled by plugging, and on the removal of the gauze a thorough inspection of the accessible parts of the cavity is once more made and any suspicious area dealt with. Care must be taken while curetting the roof of the antrum and the angle between it and the facial wall that the infra-orbital nerve is not injured in its bony canal; further, that the recess concealed by the ridge of bone in which this canal so frequently runs must not be overlooked, and diseased membrane left untouched.

Finally, the antral cavity having been thoroughly dried, is swabbed out with pure carbolic acid and then carefully packed with iodoform worsted or gauze, or carbolised gauze, the end of the dressing being left just within the cut edges of the mucous membrane, which fall together when the lip is released from the retractor.

The after-treatment demands considerable care, and must be carried out with the greatest attention to surgical cleanliness. Two objects are aimed at—namely, the aseptic healing of the cavity, and the closure of the wound between the antrum and the mouth. In order to diminish the risk of antral reinfection a small pad of sublimated wool or unprepared gauze wrung out of boracic lotion should be placed between the upper lip and the alveolus so as to cover the wound. This should be changed repeatedly during the day after the patient has taken food, and the surface of the wound should be gently syringed with boracic lotion. The mouth is frequently washed out with the same. The first dressing is not removed until the fifth or sixth day if the temperature and local appearances do not indicate its earlier removal. The cavity is then inspected, and again plugged and redressed every third or fourth day, the plug being finally removed, and the wound allowed to close at the end of the second or third week. The dressing is not painful if carefully done, and does not subject the patient to very much annoyance. The sterilised iodoform worsted employed is preserved in one in a thousand corrosive sublimate, which should be thoroughly wrung out immediately before insertion of the plug. To some patients the taste of iodoform is objectionable, but in these cases the double cyanide gauze or sterilised gauze or worsted can be substituted at the first dressing. It will be observed that the dry method of treatment alone is adopted. Personally I have found this mode of treatment very satisfactory in a considerable number of cases, and have obtained good results with it. My experience does not agree with that of some who have found the after-treatment most distressing to the patient, and the buccal wound a danger to the antral cavity. To one who has been syringing his antrum perhaps for months, the cessation of all further treatment on his own part and the cure of the condition in a comparatively short time come as a great relief. As regards the closure of the aperture between the antrum and the mouth there is as a rule no difficulty, a permanent communication being rarely if ever established. The partial closure of the incision in the buccal mucous membrane by one or more stitches, either at the time of the operation or after the first or second dressing, will obviate this risk should it be feared. The alveolar track in which the plug has been worn usually closes readily, but to prevent infection of the cavity from that source its lower end may with advantage be kept plugged with the obturator for a few days after the operation, or preferably the track should be allowed to close a few days before the radical treatment is carried out.

Opening through the Canine Fossa with a Counter Opening through the Inferior Meatus of the Nose (Caldwell, Luc).—With a view to diminish or prevent the risk of reinfection of the sinus through the buccal wound, a modification of the previous operation is now practised. Its essential feature consists in the immediate closure of the incision in the buccal mucous membrane after establishing a large communication between the antrum and the nose. The opening in the canine fossa in the first instance is necessary as the interior of the antral cavity cannot be properly dealt with through the anterior naris. The main steps of the operation as described by Luc are as follows:—After everting the upper lip an incision commencing behind at the level of the first molar tooth is carried forward as far as the canine, the mucous membrane and periosteum being divided a few millimetres below the buccal fold between the alveolus and the cheek. In this way the introduction of the stitches at a later stage of the operation is facilitated. The periosteum is then raised, and a large opening sufficient to admit the finger is made through the facial wall, care being taken to remove the bone as far forwards as the junction of the facial and nasal walls of the cavity—that is, up to the canine ridge. By doing this the artificial opening into the nose is more easily made. The cavity is carefully curetted and inspected, and then swabbed out with a strong solution of chloride of zinc (1 in 10 or 1 in 5), and temporarily plugged with iodoform gauze so as to arrest the oozing of blood. The second stage of the operation is now carried out; the nasal chamber on the same side is first plugged with gauze so as to avoid injury to the septum nasi. By means of a gouge introduced through the canine opening the antero-inferior portion of the nasal wall of the antrum is removed; the electro-motor burs will greatly facilitate this step in the operation. The nasal mucous membrane is then dissected off along with the anterior half of the inferior turbinated bone, and the establishment of a large communication between the sinus and the nose is thus ensured (Fig. 4.) The antral cavity is again plugged from the mouth, and the end of the dressing passed through the naso-maxillary opening for future extraction by that route. The incision in the buccal mucous membrane is now closed with catgut sutures threaded upon a slightly-curved needle. This wound is probably healed upon the third or fourth day, but care must be taken in the interim to prevent the contact of food with it. The plug is extracted from the antrum through the nose four or five days after the operation. The use of the handkerchief may then be found sufficient for getting rid of any abnormal secretion in the cavity; it is found advisable, however, to wash it out through a curved cannula or Eustachian catheter during the succeeding four or six weeks. If at the end of that time, after an interval of seven days the fluid is returned clear, the cure may be considered complete. This operation is not indicated when there is any co-existing sinus disease, or when antral suppuration is complicated with an atrophic rhinitis; under such circumstances reinfection of the antrum from the nose would probably occur. The advantages claimed for this procedure by the authors are to be found in the rapid closure of the buccal wound with consequent diminution in the risk of reinfection of the sinus from the mouth, and in the avoidance of repeated plugging. On the other hand, the propriety of establishing a large permanent opening between the nasal and antral cavities is open to question.

B. *Treatment of Chronic Suppuration of the Frontal Sinus.*—When the treatment of this condition comes under consideration there are—as in the case of the antrum—two methods open to discussion—namely, irrigation of the sinus through the natural orifice by way of the nose, and the radical treatment by an external operation. In order to effect a cure in the majority of cases it is necessary to remove all intra-nasal disease so as to prevent reinfection of the sinus, to establish free drainage into the nose, and to restore the lining membrane of the sinus to a healthy condition. Further, these requirements must be satisfied with the least possible disfigurement to the patient. Owing to the situation of the ostium frontale at the most dependent part of the cavity, drainage is, as a rule, good, and probably for this reason there is a greater tendency to spontaneous cure in cases of acute frontal sinus suppuration than in similar conditions of the antrum. When the chronic form is met with, it may therefore be right to assume that it is due to imperfect drainage combined with an altered condition of the mucous membrane such as has already been described. It is undoubtedly the case that these changes are very frequently met with in the frontal sinus in chronic cases. Under these circumstances we naturally ask ourselves how far imperfect drainage and a thickened mucosa can be influenced by irrigation through the nose, and whether in any of these cases it is worth while giving this method of treatment a trial. It is true that occasionally a successful result is thus obtained, but far less frequently than in the case of the antrum. The disadvantages of the method appear to outweigh the isolated cases of successful treatment. Further, the existence of anatomical irregularities and incomplete subdivisions of the sinus interfere with satisfactory irrigation of the whole cavity, while it is difficult to deal thoroughly through the nose with all the ethmoidal disease which is so frequently coexistent. Again, irrigation cannot be readily carried out by the patient himself. It is necessary, in a word, to condemn any attempt to enter the frontal sinus by boring upwards from the nose through the floor of the cavity. A perusal of Spiess's paper dealing with this procedure aided by the Röntgen rays does not lead one to modify views previously held regarding the danger of this method. As the technique of the external operation still further improves, in all probability we shall cease to consider such points as these just referred to, and in all cases at once proceed to perform the external operation.

When persistent headache, pain referred to the sinus, or localised swelling indicate inefficient drainage, the operation should be urged upon the patient, so as to avoid the danger of orbital or intra-cranial complications. In proposing the external operation, it is only fair to point out to the patient that slight scarring is inevitable, and that a certain amount of disfigurement may follow, though in many cases this is slight. The surgeon should himself bear in mind that it is sometimes necessary to perform a second operation, and that several fatalities have now been recorded, death being due to an acute septic infection of the cranial bones and meninges following operative interference. In all probability in these cases imperfect drainage and incomplete removal of the diseased ethmoidal cells led to infection of the frontal diplöe and extension to the cranial contents. With due care in carrying out the operation such an unfortunate termination should be avoided.

(i) *Irrigation of the Sinus through the Ostium Frontale.*—Although this is not advocated here as a routine method of treatment, it is necessary for the sake of completeness to refer to the procedure. The preliminary steps consist in snaring all nasal polypi that may be present, and in removing the anterior portion of the middle turbinated bone. To effect the latter Walsham's nasal scissors or Grünwald's forceps are introduced through the nostril, and under the guidance of the eye the attachment of the bone to the outer wall of the nose is divided. This section is made horizontally from before backwards through the thin neck of the bone lying above its more expanded anterior inferior extremity. The loop of a nasal snare is then passed along the incision thus made, and the portion included therein is removed (Fig. 2). All polypi thus brought into view must be dealt with, and by means of the punch forceps and the curette diseased ethmoidal cells are broken down and the passage into the sinus still further opened up. More than one sitting is probably necessary to effect this. After an interval of a few days an attempt should be made to pass the frontal cannula and wash out the sinus (*vide* Diagnosis, p. 429). A weak solution of boracic acid is useful for this purpose, and at first daily irrigation of the cavity may be practised with it.

(ii) *The External Operation.*—It is very necessary, as a preliminary and important stage of the radical treatment, to thoroughly remove from the nose all diseased tissue that is accessible, along with the middle turbinated bone, some days prior to the major operation.

Both eyebrows are shaved and the skin of the forehead carefully disinfected on the evening before the operation. The removal of both eyebrows, even in unilateral affections, is mainly for cosmetic reasons, as equality in the new growth of hair is thus ensured. Occasionally, too, in the course of the operation it has been found necessary to open both sinuses. It is unnecessary to interfere with the hair of the head, as during the operation it is covered with a sterilised or antiseptic towel. Boracic lotion alone should be employed during the operation, so as to avoid any injury to the eyes by the use of stronger solutions. A general anæsthetic is administered through a Junker's inhaler. Throat sponges and a gag should be held in readiness. Herbert Tilley recommends plugging of the posterior nares in order to prevent the passage of blood into the larynx; but this procedure is not essential.

Very satisfactory access to the sinus, along with the least possible disfigurement, is obtained, in most cases, through the eyebrow incision. Should this be found insufficient at a later stage of the operation, a vertical cut may be made upwards from its inner end in the line of one of the natural furrows or wrinkles. The incision is commenced at the inner end of the supra-orbital margin at a point corresponding to the position of the fronto-nasal suture (Fig. 3). Thence it is carried upwards and outwards to the supra-orbital notch following the curve of the bone. An incision of this length readily admits of the sinus being opened in the majority of cases. It can be prolonged outwards at a later stage if the size of the sinus should render this necessary. It is difficult to avoid injury to the supra-orbital nerve and artery even when the sinus is of average size. All the structures are divided down to the bone, and bleeding is arrested. The soft parts, including the periosteum, are then raised and pulled upwards by a blunt hook or small retractor. The portion of the anterior sinus wall thus exposed lies immediately above the root of the nose, and occupies the interval between the mesial plane of the forehead and the most internal part of the supra-orbital margin (Fig. 3). If there is any doubt about the presence of a sinus or its size, or the position of the intervening septum, the area above described offers the surest site for entering the cavity. The thickness of the bone varies in different cases, but it is readily removed with a small chisel and mallet. The mucous lining of the cavity then shows itself as a dark blue membrane readily recognisable as such, whether in a healthy or diseased condition. In this respect it presents a distinct contrast to the white appearance of the dura mater. It may be noted further, that in the event of there being no sinus, the dura mater is not reached by chiselling until considerably more bone has been removed than what usually constitutes the anterior wall of a sinus in the majority of European skulls. When the mucous membrane has been exposed it is incised and a bent probe is introduced, so that the extent of the cavity in its various directions and the position of the intervening septum may be definitely ascertained. Pus probably escapes from the sinus during this manœuvre. If the cavity is found to be a small one the opening is only slightly enlarged; but if there is a considerable upward or outward extension of the cavity, more bone must then be removed either with the chisel or with some form of cutting forceps. The supra-orbital margin for cosmetic reasons should not be interfered with, as a greater falling in of the soft parts follows in consequence of this. Practice differs with regard to the amount of bone that is taken away, a point which will be dealt with later. It must, however, be borne in mind that a large sinus can be satisfactorily treated without interfering to any great extent with its anterior wall, thus greatly lessening the risk of future disfigurement.

After carefully mopping out the cavity with gauze and inspecting its interior so far as is possible, the thickened and often polypoid lining membrane is curetted with the sharp spoon. The various curved instruments referred to under antral treatment are equally serviceable here. Careful attention must be directed to the investigation of all recesses and subdivisions of the cavity. This remark applies especially to the external angle of the sinus where these anatomical irregularities more frequently occur. Failure to remove the disease from such areas may render the treatment abortive. The septum and the condition of the bony walls must also be examined, and any deficiency in them duly recognised. The frequent backward extension of the sinus along the roof of the orbit must also be explored.

The next step in the operation, and one on which much of its success depends, consists in enlarging the ostium frontale and fronto-nasal passage in order to establish a free opening into the nose, and at the same time to remove every trace of diseased mucous membrane not previously dealt with by intra-nasal treatment. This may be effected by means of sharp spoons of varying size. Herbert Tilley employs a series of curved burs of progressive sizes for this purpose. The operator may find it expedient, in the first place, to pass a probe from the sinus into the nose, which serves, so to speak, as a pilot. The diseased anterior ethmoidal cells are thus destroyed by curetting, and a large opening made through which the little finger may be passed. The cavity is then thoroughly dried and carefully inspected, after which its interior is swabbed with pure carbolic acid, and packed through the forehead incision with iodoform worsted or gauze, or with Lister's double cyanide dressing. The end of the worsted is brought out through the lower angle of the skin incision; the periosteum and soft parts are replaced, and the wound accurately sutured, with the exception of the small portion occupied by the end of the worsted strand. No drainage tube or strip of gauze is passed from the sinus into the nose. A superficial dressing and bandage, which necessitates the covering in of the eye at the same time, are applied.

The after-treatment is regulated by the temperature and the appearance of the wound. It is advisable to remove the bandage in twenty-four or thirty-six hours in order to inspect the eye, as in one case I found that conjunctivitis had been accidentally induced during the operation. If the wound follows an aseptic course the packing may be left *in situ* for seven or eight days, and then removed. The small aperture then readily closes, or healing may be assisted by the introduction of a suture. The stitches should be removed at the earliest opportunity so as to avoid any future marking from this cause. The short curved incision does not lend itself to the introduction of a subcutaneous suture.

Unfortunately recurrence of suppuration in the sinus may take place, an undesirable result, which is probably due to its reinfection from the nose, from failure to remove all the diseased lining membrane, or from overlooking some area of carious bone. In some cases it is possible by opening up the wound, and by daily irrigation and packing of the cavity, to again establish an aseptic condition, but it may prove necessary to carry out a second or even a third operation before a successful result is obtained.

Several cases have now been recorded in which an acute osteomyelitis of the frontal bone has resulted from surgical interference, followed by meningitis or a general septicæmia terminating in death.

I have thus endeavoured to sketch the operation which is more or less successfully performed at the present time, and which appears to satisfy surgical requirements in the majority of cases. It closely resembles the method usually referred to as the Ogston-Luc operation, although differing in some minor points of detail. The latter surgeon after packing the sinus brings the lower end of the gauze plug into the nasal chamber, completely closing the skin incision. This plug he removes through the anterior naris two or three days later. Walker Downie, after bringing the outer end of the gauze strip through the opening in the bone, passes it through a small buttonhole incision made in the skin close to the reflection of the upper eyelid, and concealed beneath the supra-orbital margin; the eyebrow incision is then completely closed. I have found this method satisfactory, permitting as it does accurate apposition of the edges of the wound, while the buttonhole is afterwards hardly visible. It possesses this disadvantage, however, that if the cavity should require to be repacked, it cannot be done through the buttonhole, and therefore it necessitates the reopening of the first incision. Herbert Tilley gradually removes the gauze plug through the forehead wound, cutting off about 3 inches every third day, and finally removing the remainder when the cavity is completely lined with healthy granulations. The employment of a drainage tube passing from the sinus to the nose has now been practically abandoned by nearly all operators, the worsted or gauze plugging having been substituted. I would strongly urge that after a radical operation upon the maxillary or frontal sinuses treatment by packing should be carried out, and that all irrigation should, if possible, be dispensed with.

Different methods of dealing with the anterior bony wall of the sinus must be briefly referred to. The question of the removal of bone is of considerable æsthetic importance, and must receive a due amount of consideration from the surgeon. Kuhnt advocated and practised complete removal of the anterior wall. When the cavity is small and shallow an attempt may be made to obliterate it by the apposition of the superficial soft parts against the posterior sinus wall, a procedure which is followed by a certain amount of depression of the skin surface. When the sinus is large and extends backwards along the roof of the orbit, it is impossible to completely obliterate it in this way, and the disfigurement which results from the removal of an extensive area of bone is considerable. The sex, age, and the feelings of the patient are factors which must be taken into account in reference to this point, while experience justifies us in promising, in a large number of cases, satisfactory results without the removal of the whole anterior osseous wall. Howard Lothrop in one case turned down from this wall a flap of bone and periosteum which he afterwards replaced. Jansen, recognising the frequent association of ethmoidal suppuration, has removed the inferior wall of the frontal sinus through an incision made immediately below and parallel to the supra-orbital margin. In this way more ready access to the ethmoidal cells was obtained. Osteoplastic operations have also been introduced by Czerny, Kuster, and Winckler, with the object of completely removing the disease with the minimum of disfigurement. Skin grafting of the interior of the sinus by Thiersch's method will in the future probably play an important part in the after-treatment of these cases. Tilley has recently reported a successful case of this kind.

When both frontal sinuses are affected some operators enter each cavity through a mesial vertical incision, and if both sinuses are small this single incision readily suffices. Others, again, unite the eyebrow incisions across the mesial plane, and from the centre of this carry a vertical cut upwards. In bilateral affections it certainly seems better to operate upon each cavity through a separate eyebrow incision. Two advantages may be claimed for this manner of procedure. The after-treatment of each sinus can, in this way, be carried out independently, a point of some practical importance if one of the cavities should continue to suppurate; further, the scars are at the same time confined to the region of the eyebrow as in the case of a unilateral sinus affection.

When the frontal and maxillary sinuses of the same side are affected both should be dealt with at one operation, in order that every source of infection may be removed from the nose at the same time. Should the surgeon deem it advisable to complete the operation in two stages, it is better to open the frontal sinus in the first instance, so as to prevent any reinfection of the antrum by discharge passing downwards from the untreated frontal sinus.

C. *Treatment of Chronic Suppuration in the Ethmoidal Cells.*—In discussing the treatment of frontal sinus suppuration we have already referred to the frequent coexistence of disease in the anterior ethmoidal cells, and have shown how the latter affection must be dealt with when thus associated. The treatment of ethmoid disease *per se* is conducted along similar lines, with this difference, however, that it is carried out entirely through the intra-nasal route. The general surgical principles involved consist in the establishment of free drainage and the removal of every focus of diseased mucous membrane; the possible existence of suppuration in one or more of the other sinuses must always be borne in mind and systematically dealt with, otherwise failure to cure the ethmoid affection will result. The method of operating will depend to a large extent upon whether the disease is limited or extensive. In the former case cocaine is applied, and with the aid of good illumination the polypi which are present are in the first instance snared, and the greater portion of the middle turbinated bone removed. At subsequent sittings the process of snaring, punching, and scraping diseased mucous membrane and bone is repeated until the surgeon has satisfied himself, if possible, by careful inspection and probing, that every trace of disease has been removed. Owing to hæmorrhage which masks the field, and in some cases owing to the patient's inability to tolerate a prolonged sitting, several operations are necessary, even in those cases in which the disease does not appear to be extensive. The ethmoidal region may be temporarily plugged with gauze so as to control bleeding, but it is not advisable so long as foci of suppuration exist to check the free exit of discharge by firm packing.

In the second group of cases, where the disease is extensive and appears to involve the whole ethmoid labyrinth, a more complete operation, carried out at one sitting and under a general anæsthetic, is recommended. The operation is conducted under such circumstances by the sense of touch, and not under the guidance of the eye. Lambert Lack, who strongly advocates this line of procedure in suitable cases, examines the ethmoidal region with the finger introduced both through the anterior and posterior nares. The middle turbinate bone is removed with the spokeshave, and large polypi by means of forceps. The lateral mass of the ethmoid is then thoroughly scraped away with a large ring knife, an instrument which he considers much more effective than the sharp spoon. From time to time the finger is introduced so as to determine the presence of diseased areas of bone, and to define the limits of the healthy tissue determined by its smooth, firm, and resistant feel. It is unnecessary to emphasise the necessity of exercising the greatest care when working in proximity to the cribriform plate and os planum of the ethmoid bone. At the end of the operation all hæmorrhage is arrested by packing the cavity with a strip of gauze soaked in glycerine-iodoform emulsion, which should be changed every second or third day and the nose syringed. This radical procedure, which has been attended with very considerable success in Lack's hands, is advocated on the grounds that it is less irksome, tedious, and painful for the patient, and that more satisfactory results are thus obtained. Those cases of ethmoid disease which are associated with orbital phlegmon and abscess, or with the formation of an orbital fistula, demand an external operation in addition to the usual intra-nasal treatment. In the latter case the fistula must be enlarged, and the communication with the ethmoid cells sought for. Where there is no external opening the labyrinth may be entered through a curved incision closely resembling that employed in opening the frontal sinus, but which is prolonged downwards towards the inner canthus of the eye. By raising the periosteum along with the soft parts the inner wall of the orbit is exposed. If a communication with the bone is found it is opened up, the ethmoid cells curetted, and a free passage established with the nasal chamber. By the use of gauze pledgets the hæmorrhage may be satisfactorily controlled. After swabbing the cavity with pure carbolic acid it is plugged with gauze, and the external wound is partially closed.

D. *Treatment of Chronic Suppuration in the Sphenoidal Sinus.*—The removal of the middle turbinated bone, which has already been effected for diagnostic purposes, or which may have been removed in the treatment of ethmoidal disease, forms a necessary preliminary stage in the treatment of sphenoidal sinus suppuration. The subsequent steps should consist in the establishment of free drainage, and in the removal as far as possible of all diseased mucous membrane. While it is true that in a certain number of cases the natural opening can be catheterised and the cavity in this way satisfactorily washed out, it must not be forgotten that the orifice is small, and is usually situated some distance above the floor of the sinus. Better drainage can therefore be established by breaking down the anterior sinus wall, a procedure which also permits of the subsequent introduction of the curette, and the scraping of the interior of the cavity. The operation is performed through the anterior naris under cocaine anæsthesia, and with the aid of good illumination. Hajek introduces a small but strong hook into the sphenoidal opening, and, so to speak, tears down its anterior wall, the pieces of bone and mucous membrane thus partially detached being then removed with forceps. The same result may be obtained by means of a sharp spoon, and into the orifice thus enlarged one of the blades of a pair of punch forceps, as recommended by Grünwald, is introduced: portions of the bone are then rapidly punched out, and the opening considerably enlarged both downwards and laterally, the greater part of the anterior wall being in this way removed. The cavity is then packed with gauze for twenty-four hours. In the majority of cases this opening tends to contract and close comparatively early. Should it be deemed advisable or necessary to scrape the sinus, the sharp spoon must be employed with care, and mainly in a downward direction, so as to avoid any pressure upon the thin roof of the cavity. Indeed, in all manipulations connected with diagnosis and treatment due care must be exercised in dealing with the upper and outer walls of the sinus. The swabbing of its interior with pure carbolic acid, followed by irrigation at intervals, may greatly improve the patient's condition, and lead to a permanent cure. Grünwald, whose experience in the treatment of sphenoidal sinus disease is considerable, has obtained very satisfactory results. Several of his cases completely recovered in a few weeks, while in none of them did the period of treatment exceed four months. Both Jansen and Luc have opened the sphenoidal sinus through the antrum in cases complicated with disease in that cavity and in the ethmoidal cells. By making a large opening in the canine fossa and resecting the nasal wall along with portions of the middle and inferior turbinated bones, the anterior wall of the sphenoidal sinus was exposed to view and then removed.

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Nose: Foreign Bodies, etc.

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Etiology.—Foreign bodies may enter the nasal chambers—(1) through the anterior nares; (2) through the posterior choanæ; or (3) by penetrating the walls of the cavities. They may also arise *in situ* in the form of necrosed sequestra and rhinoliths. This last group will be considered separately.

The majority of cases occur in children. It would be impossible to enumerate the various articles which they have in play pushed into their nostrils, but the list would include buttons, beads, peas, beans, fruit-stones, and the like. Lunatics sometimes introduce various articles through the anterior nares. In adults the most common objects are portions of cotton wool or gauze, which have been inadvertently left in during treatment. Foreign bodies may gain access to the nostrils through the posterior choanæ during violent vomiting. When substances reach the cavity through its walls it is generally due to some external force—frequently some firearm.

Symptoms.—These will vary according to the size, nature, and situation of the substance introduced. There may be some discomfort and irritation, or even a considerable amount of reaction, but in many cases the introduction is followed by a period of tolerance, which may last from a few days to ten, twenty, or forty years. Sooner or later reaction sets in, and is manifested by an ichorous, one-sided, fœtid discharge, which is frequently blood-stained. Nasal obstruction and various reflex symptoms may be present.

With good illumination and nasal speculum and a probe the presence of a foreign body can generally be definitely demonstrated. In young children it is frequently necessary to give a general anæsthetic, when not only can the diagnosis be confirmed, but extraction can also be completed.

Diagnosis.—The history of the accident may help in the diagnosis, and in children the presence of a chronic unilateral discharge, especially when offensive, is always suggestive of a foreign body. It may be mistaken for a rhinolith or syphilitic necrosis, but as the treatment is identical in all cases the differentiation is not important. In adults it might be mistaken for an empyema, and in children it must not be confused with nasal diphtheria or membranous rhinitis.

Prognosis.—Once the foreign body is extracted the symptoms it gave rise to speedily disappear.

Treatment.—The probe used for diagnosis will frequently be of help in levering the substance into a suitable position, whence it can be extracted with a small crotchet hook, nasal snare, or suitable forceps. This should always be carried out under the control of the eye. In children a general anæsthetic is frequently required. If it is found impossible to remove the foreign body through the anterior nares it may be pushed backwards into the naso-pharynx, where the forefinger of the left hand is ready to prevent it from falling into the gullet or larynx.

The after-treatment consists in simple cleansing measures.

RHINOLITHS

Synonyms.—Nasal calculi, concretions in the nose.

Etiology.—Nasal concretions are generally one-sided, irregularly spherical, gray, friable, and with a rough mulberry surface. On analysis they are found to consist of various salts, chiefly phosphate and carbonate of lime. On section it is seen that these salts have been deposited around a nucleus of some foreign body, or perhaps some blood clot or inspissated mucus.

Symptoms.—These will to a considerable extent resemble those caused by a foreign body. A one-sided discharge and obstruction are the chief indications for a careful exploration of the affected nostril, when the probe will generally settle the diagnosis.

Diagnosis.—This frequently cannot be definitely determined until the rhinolith has been extracted, but the provisional one of some foreign body is sufficient (*vide* "Foreign Bodies," p. 446).

Prognosis.—Once completely removed there is no tendency for nasal calculi to reform.

Treatment.—This is carried out on precisely the same lines as indicated in the section on foreign bodies. In some cases, owing to the continuous accretions to the outer surface and the irregularity in their development, it is sometimes necessary to crush the rhinolith and syringe out the fragments from the opposite cavity.

PARASITES OF THE NOSE

Synonyms.—Myasis narium, larvæ in the nose, maggots in the nose, Entomozoaria in the nose, animate foreign bodies in the nose, Peenash (a term used in India).

Symptoms.—The occurrence of animate foreign bodies within the nasal chambers is fortunately very rare in temperate climates. In India, South America, and other tropical countries, the presence of larvæ in the nose is not uncommonly met with in the natives, in whom it is associated with extensive ulceration of the nasal cavities, pain, epistaxis, septicæmia, and sometimes convulsions, coma, and death. The eggs of certain flies of the order of *Muscidæ*—and chiefly the *Lucilia hominivora*—are deposited in or near the nasal cavities, to which they are particularly attracted by any purulent condition. The incubation period is short, and within a day or two symptoms of irritation may be set up. How acute these may be can be judged from the fact that sometimes as many as 200 maggots have been expelled in a single case. Fortunately these larvæ can be readily destroyed and removed by spraying or pouring any oily substance into the nose, or syringing it with chloroform mixed with an equal quantity of water, or pure chloroform may be used after the patient has been anæsthetised.

Amongst the Entomozoaria which are rarely met with in the nasal fossæ are leeches, centipedes, earwigs, and ascarides. The symptoms will usually consist of formication in the nose, discharge, obstruction, vomiting, lachrymation, sleeplessness, and excitement. The most trustworthy remedy is chloroform, given as already indicated.

Nasal Hydrorrhœa

Synonyms.—Rhinorrhœa, dripping from the nose.

Definition.—An obscure nasal affection characterised by profuse watery discharge from the nostrils, without marked visible changes in the nasal chambers.

Etiology.—The affection is one of adult life, and sufferers are generally of the same type as those who are affected with hay fever.

Pathology.—There are no marked changes in the mucous membrane of the nose. The fluid, however watery it may appear as it falls from the nose, is found when collected to be thick, viscid, and slightly opalescent. Under the microscope it shows amorphous matter and mucous corpuscles. With acetic acid or alcohol it gives a stringy precipitate of mucin. It contains a small amount of proteid coagulable by heat, it does not reduce Fehling's solution, and it contains 1·208 of total solids. When the fluid amounts, as it does sometimes, to a pint or more in the day, it is less viscid and much weaker in mucin.

Symptoms.—The chief complaint is of a watery discharge from the nose, varying from a few teaspoonfuls to a pint or more in the twenty-four hours. The fluid generally escapes from both nostrils, although it may be more marked on one side than on the other. The flow rarely continues during the night. It is apt to be erratic in its onset and in its intermissions. In some cases nothing but the discomfort is complained of, while in others there are symptoms of local irritation and of reflex disturbance. Handkerchiefs soaked with discharge become stiff when they are dried, owing to the amount of mucin in the secretion.

Diagnosis.—This is based on the characters of the fluid, and on the exclusion of any intra-nasal or neighbouring sources of irritation.

Prognosis.—The affection is without seriousness to life. Spontaneous cessation will frequently occur, and remedial measures are generally successful in mitigating the discomfort of the complaint.

Treatment.—Unless there is any decided hypertrophy or irregularity in the nasal chambers, or some definite sensitive spots can be discovered, the use of the galvano-cautery or other caustic should be avoided. The profuseness of the flow can often be checked by painting or spraying the nose with a solution of suprarenal extract. The administration of liquor atropiæ in $\frac{1}{2}$ or 1 minim doses, especially in combination with liquor strychniæ, or of $\frac{1}{20}$ - $\frac{1}{12}$ grain of extract of belladonna, is particularly serviceable. General treatment, with change of climate and a visit to some suitable spa, will frequently secure very satisfactory results.

Cerebro-Spinal Rhinorrhœa

Synonyms.—Dripping from the nose, escape of cerebro-spinal fluid from the nose.

Definition.—This is apparently a rare occurrence, in which the cerebro-spinal fluid can spontaneously escape from the anterior fossa of the skull and pass into the nose.

Symptoms.—It has long been known that after injuries to the base of the skull the arachnoid fluid can escape by way of the nasal fossæ, but it does not appear to have been positively established as a pathological possibility that this escape could take place spontaneously until the publication of a monograph by St. Clair Thomson with a critical study of 21 cases.[1] From this it appears that the chief, and often only complaint is of a constant and long-continued escape of watery fluid from one side of the nose. If collected the fluid is found to be limpid like water, free from taste, smell, and sediment; albumin and mucin are practically absent from it, and when boiled with Fehling's solution there is a reduction of the copper (due to pyrocatechin or some similar body).

Diagnosis.—It is important to distinguish this watery discharge from other forms of rhinorrhœa. This is arrived at to some extent by a process of exclusion, but also by noting the characters of the fluid and the fact that when handkerchiefs soaked with it are dried they remain soft, and can be used again (owing to the absence of mucin).

Prognosis.—The condition does not appear to be amenable to any treatment, although in some instances the flow appears to have ceased spontaneously, and it will often intermit for irregular periods. Several of the cases recorded have been followed by changes in the retina and blindness, and by cerebral symptoms and death. Possibly these accidents will become rarer when the true nature of the condition is recognised in good time.

Pathology.—The fluid may escape from the cranium along the perineural sheaths of the branches of the olfactory nerves, or by a communication between the subarachnoid space and the lymph channels of the nose, or by a simple solution of continuity in the dura mater lining the anterior fossa of the skull.

Treatment.—No remedy has been suggested for this affection, and if possible it is advisable to refrain from all intra-nasal treatment to avoid the risk of infection being conveyed to the meninges.

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See also INFANT-FEEDING; MILK; CHILD, DEVELOPMENT OF.

INFANTS and young children are more sensitive to their surroundings than individuals of maturer years; they suffer more from exposure to cold and damp, bad air, and want of cleanliness; they stand in need as much as their elders of the invigorating influence of sunshine and fresh air. Indeed warmth, fresh air, and sunlight are as necessary to the well-being of infants as suitable food; while exposure to cold, neglect, dirt, and the foul air of dingy and crowded dwellings, are important factors in producing the high infant mortality in our large cities, as well as much sickness and ill-health.

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[1] *The Cerebro-Spinal Fluid: its Spontaneous Escape from the Nose.* London. Cassell & Co. 1899.

Our large cities, with their murky atmospheres, and cold wet climate, are anything but ideal places for infants and children, and many of the weaker ones fail to thrive under the conditions of city or town life. There seems some reason to think that as far as town dwellers are concerned, the race is steadily degenerating, and unfortunately the tendency is more and more to depopulate the country and overcrowd the cities. A healthy infancy lays the foundation for healthy after life. Healthy infancy can only be secured by rational feeding and careful hygiene.

Nursery.—Much care should be bestowed in making the nursery bright and comfortable, as the children of the household have necessarily to spend much of their time there, when it is impossible for them to be outside in the open air. Let the nursery face south with as open a prospect as possible; rooms facing north and east are liable to be dull and cold, and in our British climate we want to catch the sunbeams for the greater part of the year. The window space should be ample, and the windows must be made to open widely so that the room may be flushed daily with volumes of fresh air. There should be an open fire-grate of sufficient size to heat the room efficiently, and this must be protected by a fire guard three or four feet high to prevent accidents. Draughts must be avoided by placing a screen or curtain reaching to the floor between the door and the fireplace. In furnishing a nursery it is wise to remember that sooner or later there will likely enough be an outbreak of infectious disease among the inhabitants of the nursery, and its contents will have to be turned out and disinfected or destroyed. For this reason anything luxurious or expensive is out of place. Painted walls or washable wall papers are convenient, as it is easy to wash down the walls with some disinfectant. The furniture, cushions, blinds, curtains will require to be boiled, or stoved, or destroyed. Picture frames catch the dust, and are not easily disinfected, whereas cheap coloured pictures taken from the illustrated papers may be varnished, and taped round their edges, and fastened to the walls with tacks. These can be replaced when torn or dirty at a small cost. But after all a child prizes more a toy in its hands than a picture on the wall; toys are cheap, and should be burnt after a visitation of infectious disease. Cork linoleum makes a cleanly surface for the floor of the nursery, as many crumbs and much food débris are apt to fall from the nursery table.

The night nursery should be carefully warmed and ventilated; it is altogether wrong for an infant to spend the day in a nursery heated to 60° or 70°, and the night in a temperature of 30°-40° F. If the nursery is well warmed the bedclothes need not be heavy, and there is no excuse for covering up the infant's face with the bedclothes as is so often done. A gas fire fitted to an efficient chimney flue, so that all the products of combustion may pass off, is a cleanly and economical form of fire. On no account use a gas fire or paraffin stove without a chimney flue, and see to it that there is no down draught. The cot should be of the type known as the hospital cot, with the sides letting down for convenience in placing in the infant. Enamelled iron or wood are the best materials; brass cots look very well when new, but they soon tarnish and require much polishing up. Cradles which swing or rock are not necessary; there is no reason in the world why an infant any more than an adult wants "rocking" to sleep, indeed the movement is bad, and in some induces sickness. No curtains are necessary, as care should be taken not to place the cot in a draught. A horse-hair mattress should be used; this is usually covered with a stout piece of mackintosh waterproofing, and an old blanket doubled over this for the infant to lie on. The infant must on no account be allowed to share its mother's bed, as the risk of "overlying" or suffocation under the clothes is very considerable. The mother and nurse must be warned not to cover the baby's face with the bed-clothes, as they are apt to do in cold weather, as this foolish proceeding is responsible for much loss of infant life, not only among the poorer, but also among the well-to-do classes. There is reason to believe that many deaths of young infants certified as "convulsions" are in reality deaths from suffocation. Maintain a suitable temperature in the night nursery all through the night, and then there is no need for heavy bed-clothes or for covering up the baby's face.

In the case of immature or weakly infants a cot may be very readily provided by lining a suitable wicker-work basket with Gamgee tissue and absorbent cotton wool for a mattress. The napkin can be made of a similar material, and the infant wrapped in cotton wool instead of being dressed. One or more rubber hot-water bottles may be placed in the cot at a suitable distance from the infant. The nursery both day and night must be maintained at a higher temperature (about 70° F.) than is necessary for a vigorous infant.

Nurses.—Serious attention has been paid during the last few years to educating and training nurses for infants and children, and raising their status more nearly to the level of those engaged in sick-nursing. A well-educated, refined, and capable nurse is simply invaluable; a vulgar, unreliable, or feckless and ignorant one may do untold mischief to the health and morals of infants and children. How much a good nurse can effect by training in the nursery! By carefully attending to the infant's wants she may save much wetting and soiling of napkins and clothes. She can get her baby off to sleep when irritable and feverish when no one else can. She can save exhibitions of temper and much unnecessary crying in the nursery. By attention to the feeding she may prevent not only minor ill, but serious illness. Such a nurse is indeed a blessing, and deserves to be well paid and treated with every consideration in the household.

Bathing.—Infants are usually bathed in the morning before being dressed, while older children are mostly bathed at night. The infant's morning bath is necessary on account of the fouling of the napkin during the night, and the consequent necessity of a thorough cleansing of the skin about the groin and buttocks. It is unnecessary to say that the wetting of the napkin during day or night should be avoided as much as possible by holding the infant out over the chamber vessel. The temperature of a baby's bath should be about blood-heat; the infant quickly loses heat when exposed to a temperature lower than its own tissues, and if placed in too cool a bath it quickly becomes blue and depressed. On the other hand, a bath of too high a temperature, or too long a stay in the water, soddens the skin and makes it tender. If the thermometer marks 100° F. when the bath is filled, the temperature of the water will be about right by the time the infant has been undressed and got ready. The nurse usually covers her lap with a mackintosh and blanket, then uses flannel and soap, especially about the buttocks and other folds of the skin, puts the infant in its bath for a minute or so to remove the soap, and then rapidly dries it with a soft towel. As the infant gets older it may be allowed to stay longer in its bath, as it can stand the water better. For older children a morning sponge all over with tepid or cold water is invigorating and healthful;

delicate children should stand with their feet in warm water during the sponging process. They should be well rubbed down with a warm towel after the douche.

Clothing.—The most unsatisfactory article connected with an infant's wardrobe is the napkin, and the sooner the infant can be taught to do without it the better it will be for its health and comfort. It should be the aim of every good nurse to train the infant to do without a napkin as soon as possible. Whenever a napkin is wetted or soiled it should be at once removed, and the infant's buttocks cleansed with soap and water, carefully dried, and a clean warm napkin applied. Uncleanliness in this respect, and contact of wetted napkins with the skin for any length of time, is certain to produce fretting and irritation of the skin. Powders are unnecessary in healthy infants if the skin is well dried, but if there is redness or excoriated skin, the affected part after cleansing and drying may be dusted with starch and boric acid, or starch and zinc oxide; whatever powder is used, it should be *finely* ground. Ointments are greasy, dirty, and often injurious. To smear an ointment over a half cleaned and still filthy "napkin area" is to invite disease. It requires a good and capable nurse to keep the buttocks of an infant in a healthy state when it is suffering from severe diarrhœa. Soiled napkins, especially if the infant is suffering from diarrhœa, ought never to be allowed to accumulate in the nursery or bathroom. The diarrhœa stools of an infant are frequently capable of conveying infection to others, and in consequence should be removed from the nursery, and if possible disinfected, by immediate boiling. The nurse's hands should be carefully washed. Where it is not possible to disinfect by boiling at once, the soiled napkins should be well covered with carbolic powder and placed in a pan fitted with a lid. The pan should preferably be kept out of doors. A still better plan of disposing of soiled napkins is to burn them at once on removal, but if this is practised the napkin should consist of a triangular-shaped piece of soft Gamgee tissue, which can readily be made in the household, or can be obtained ready made and stitched (knapkinettes). No napkin must be applied tightly. The binder is required to keep the dressing on the navel, and when the navel cord is separated it is no longer required. The broad flannel bandage which is usually applied round the abdomen of infants is of use as a protection from cold, but applied as it often is, it compresses the lower part of the chest, preventing or hindering the expansion of the lower lobes of the lungs. There can be no good and much harm may be done in bandaging the infant up tightly. The abdomen varies in girth from time to time, according to the distension of the intestines with gas, and an elastic open material is much better for a covering than an unyielding bandage. A Shetland wool abdominal belt fulfils every purpose, and cannot compress or overload the abdomen. With regard to the other articles of clothing, they should be warm and loose, being constructed for utility rather than show. The infant's "long clothes" should be placed in a museum as relics of antiquity, they are very inconvenient and useless. If the garments are made to reach three inches below the feet they will be long enough for warmth and comfort. It is advisable to have the clothes cut so that they all open in front or all open behind, not some in front and some behind; this is done as being more convenient in dressing and undressing, there being no occasion to turn the infant first on its back and then on its face. Shetland woollen vests and overalls of the same material are useful to cover the legs and thigh and enclose the napkin. Knitted woollen socks should be worn especially in winter. The shoes should be of soft material and of rational shape, so as not to compress the toes. When the child can run about sandals may be worn in the house, but they are hardly fit for our climate out of doors, except perhaps during a summer holiday at the sea-side. By ten months or a year, if the infant has been properly trained, the napkin may be dispensed with during the day time, as accidents will be rare, though it may be still required at night. When the napkin has been abolished a Shetland wool combination worn next to the skin is very suitable for wear. A knitted woollen cap of a Tam-o'-Shanter or buccaneer shape for winter, and a soft straw hat for summer, are much preferable for outdoor wear to most of the headgears made specially for infants.

By the time the infant is beginning to crawl about and attempting to walk, the frock and inner garments are shortened so as not to impede locomotion. It is a great convenience at this time to be able to do away with the napkin, as it is always slipping and coming off. The legs and buttocks want protection, and woollen or flannel drawers should be provided; but much trouble comes from wetting if the child has not been properly trained and tended, and much washing and shrinking of woollen garments is the result.

Parents rarely take much trouble with regard to the make and shape of children's boots and shoes, and the ordinary boot salesman cares for nothing but smartness in his wares. It is possible, however, to have a good selection of rationally shaped boots and shoes for both boys and girls, which will not unduly raise the heel and compress the toes.

Fresh Air.—No infant or child thrives if it is kept indoors in stuffy rooms for weeks and months together. This is certainly true of infants in hospitals as well as in private houses. If the weather is favourable the newly-born infant, if strong and vigorous, may be taken out in its nurse's arms by the end of the first week. If the weather is cold it may be warmly dressed and taken for a walk in a warmed room with the windows thrown open, so as to accustom it to the fresh air. When a few weeks old it should go out daily in its carriage, and if the weather is cold a warm water bottle should be provided. The child's carriage should have four wheels, be mounted on good springs, and arranged so that the infant's airing is taken lying down. Mail-carts are all very well for older children, but for infants under a year or eighteen months the sitting-up position is too trying, and they often want to sleep when in the open air.

Sleep.—The newly-born infant usually sleeps most of the first few days of its life; it is some time in shaking off the lethargy of prenatal life. This drowsiness is especially well marked after a prolonged labour and in infants who are born prematurely, and it is probably due to the effects of imperfectly aerated blood. All through infancy the healthy infant spends much of its time in sleep, and it is well for all concerned that it does so. It wakes up hungry and cries, its hunger is appeased by food, and it shortly drops off to sleep again; usually the waking hours during the first few weeks of life do not amount to more than three or four. After the first month the infant is more alive to its surroundings, especially during the daytime, but it should sleep continuously from eleven at night, after being fed, till four or five the following morning and some sixteen or eighteen hours out of the twenty-four. At six months of age the healthy infant has gradually undergone a "mind awakening," and is no longer content to sleep the livelong day when there is so much of movement and change going on around it; it requires, however, one or two naps during the day, and should sleep continuously through the night after its last meal. All through early childhood a midday rest is a necessity for the muscles and nervous mechanism of the child's body.

The dyspeptic infant is usually a bad sleeper, and often wears out the patience of its nurse and mother by its wakeful ways. In early rickets this is especially so: the infant sweats profusely, apparently suffers from pains and aches, and its nervous system is in an irritable condition. The healthy, phlegmatic, good-natured baby is a good sleeper, it is not easily aroused by noises, and gives little trouble to its nurse or parents. The excitable, neurotic infant, which is perhaps made worse by injudicious excitements allowed by its parents, is a bad sleeper: it will not go to sleep in the daytime, it wakes up with the slightest disturbance, at night it will perhaps lie awake for hours. When a tooth is being cut and the gums are sore and swollen, restless nights are common, as every mother knows by experience. Careful feeding, good training, and avoidance of excitement of all sorts and kinds, are the best prescriptions for wakeful babies. While bromides, chloral, phenacetin, etc., are useful and perhaps necessary, when given under medical direction, for some definite trouble, as tooth-cutting, they are baneful for habitual use, and in the hands of a reckless nurse are highly dangerous—the pitcher goes perhaps once too often to the fountain!

Weighing-Charts.—Every nursery should be provided with a weighing-machine, and the infant's weight may be conveniently recorded on a "weight-chart." Weighing-machines which necessitate slinging up the infant to a hook are inconvenient to use, on account of the struggles of the infant, and are dangerous in the hands of a careless nurse. A cradle fitted over a spring balance with a dial (Hawksley's), the pointer of which indicates 28 lbs. by 2 ounces, or the "Victoria combination scales," which weigh to 61 lbs. by half ounces, make excellent weighing-machines for the nursery. Weighing once a week is often enough during health; care must be taken to weigh at the same time of day each week in order to get average results. An error is easily introduced if care is not taken to weigh exactly under the same conditions from week to week. Charts can be obtained (Hawksley's), resembling temperature charts, with spaces for the weights to be marked in each week, and there is a dotted line indicating the average weight. It is the weight rather than the age which must be the guide to the amount and strength of the food given to the infant; but account will also have to be taken of the age and as to whether the infant is abnormally fat (see "Children, Development and Clinical Examination of").

Milk-Supply.—The greatest care must be exercised in securing milk for the nursery which is of good quality and purity. It is astonishing how little trouble is often taken by the heads of a household to satisfy themselves in this matter. They accept without demur the fiction of a "special cow kept for infants" and the various statements of the dealer, backed up, as they usually are, by the pious opinion of the cook. The city dweller, unfortunately, has to take his milk on trust, and has no means of ascertaining if the milk comes from healthy cows free from tuberculosis or other disease; that they are properly fed and cared for, and that the milk is not fouled in any way during the milking process or in transit. Most of the milk-supply of a city comes from a distance, as, for instance, some of Cheshire and Derbyshire milk goes to supply London.

Whenever it is possible the distance for milk to travel should not be great, so that the morning's milking may be delivered before breakfast of the same day, and the afternoon's milking in the evening for the night's consumption. It is best to have the milk-supply for the household put up at the dairy in clean sterilised quart or pint bottles with "lightning" stoppers, and in this way delivered at the house. This saves the risk of contamination by the dust of the street and by dirty vessels in the household. If the milk is dirty or coloured it is more readily detected when in a glass bottle than in an opaque vessel.

The foddering of the cows is a matter of much importance when the milk is to be supplied to infants. The food of the cows should largely consist of dry fodder, such as hay, corn, meal, with a moderate proportion of fresh food, such as clover and grass in the summer and beets or mangels in the winter. An exclusive diet of green food does not produce the best milk for infants, the latter often suffer from dyspepsia when the cows are first turned out in the spring. Oilcake and turnips should only be used in small quantities, if at all, and refuse from breweries should be absolutely forbidden.

The risks of the milk being contaminated are not ended when it leaves the dealer, the best of milks will go wrong if care is not taken in storing the milk in the household. Almost any vessel is thought good enough by the cook to receive the morning's or evening's milk. Beer jugs, pie dishes, pudding basins are perhaps requisitioned for the purpose, while the vessels are kept in a hot kitchen or nursery or in the foul air of a cellar. Dust is allowed to settle in the milk, and with the dust come numerous micro-organisms. The milk, as was said above, should preferably be delivered in bottles, and the bottles should be stored in a cool place or in an ice-chest.

It is a good plan directly the milk arrives in the household—especially during warm weather—to separate the infant's milk from the household's, and at once Pasteurise or sterilise the former. This may be done in one of Hawksley's sterilisers, or one of the "sentinel milk sterilisers," both of which are convenient for the purpose. The milk should be quickly cooled, and stored in a cool place (see "Infant Feeding").

The simpler the feeding-bottle the better; perhaps the best of all are those sent out with Soxhlet's sterilising apparatus, or those of a similar make. These are round bottles which stand upright, have fairly wide mouths, and will stand scalding or boiling. A narrow-mouthed bottle with flat sides does not admit of being so readily cleaned with a ring brush as the above. Fancy bottles provided with thermometers should be avoided. The teats should be large enough to be turned inside out and cleaned with a tooth brush. No tube bottle should be employed. After use the bottle should be well rinsed out, all flocculi or deposit removed with the cleaner, the bottled scalded—or, better, boiled—and placed on a rack, mouth downwards, to drain. The teat should be cleaned inside and out and set to drain. On no account permit the nurse to put the teat of a ready charged feeding bottle into her mouth to taste the food and test its temperature.

Mouth and Teeth.—The careful nurse will daily examine the infant's mouth, and note the condition of the gums and mucous membrane of the tongue and cheeks. Any accumulation of food should be cleaned away with a brush wetted with weak Condy's fluid. Infants are very liable to aphthous, parasitic, and other forms of stomatitis, and the gums become sore during dentition and spongy in scurvy. The various forms of stomatitis are due to a lowered vitality of the mucous membrane and infection with the oidium albicans and various bacteria and cocci. There is no more certain way of introducing these organisms than by using dirty teats to the feeding bottles, or by allowing the infant to be constantly sucking a blind teat or "comfort." The "comfort" is continually dropping out of the infant's mouth; it falls on the floor of the nursery, in the dirt of the street, or the floor of a tramcar, and is promptly replaced in the infant's mouth. It can hardly be a matter of surprise to find that the infant sooner or later suffers from stomatitis, and in the course of time tuberculous cervical glands.

The teeth require constant supervision during infancy and childhood, but unfortunately, in spite of every care, bad teeth are common enough. The good nurse or mother will see that the infant's or child's teeth and gums are cleaned daily, and will note any soreness of the gums or incipient decay of the teeth. The cleansing process may be effected with a soft rag in the case of infants, and a soft tooth brush for older children. An alkaline antiseptic solution, as for instance, soda and thymol or a good tooth powder may be used. (Precipitated chalk, 4 oz.; powdered curd soap, ½ oz.; carbolic acid, 20 drops; otto of roses, 5 drops. *Pedley.*) Not much can be done in the way of filling carious milk teeth, except perhaps the molars, and young children are not always very tractable when on a visit to the dental surgeon; but whenever caries is discovered in any of the permanent set no time should be lost in having them attended to.

Diets (*see* "Infant Feeding").—During the first year of life the infant's food consists entirely of fluids in the form of milk or milk food After six or seven months of age it is usual to allow some starchy food to be mixed with the milk, as for instance thin barley gruel, oatmeal gruel, or rusks made into a gruel with hot water. The food must be thin enough to pass through the nipple of a feeding-bottle. Healthy infants do not require either malted food or peptonised food. The mistake that mothers are apt to make during the latter half of the first year is to give too much starchy food, making the food too thick and pasty. Children so fed are apt to be overfat and constipated, and suffer perhaps from flatulence. Another mistake which is perhaps as common is to give infants more undiluted milk than they can properly digest. They pass pale, curdy, and foul-smelling stools, and have distended and rounded abdomens.

After the end of the first year the feeding-bottle is gradually dispensed with, the child drinking out of a cup or being fed with a spoon. This change often takes some time, as the child is clumsy at first in drinking, and splutters and chokes. The staple food during the second year is milk, from one to two pints being taken in the twenty-four hours. The diet is now more varied than during the first year; thin milk puddings, bread and milk, hominy or oatmeal porridge, eggs, broth, gravy, cooked vegetables, and cooked fruit being taken. Butcher's meat may be given in small quantities only. It should be underdone and finely shredded. The same mistake is frequently made at this time as during the first year, namely giving too much thick starchy food. Thick oatmeal porridge is heavy, and not easy to digest, and so is bread and butter in large quantities. The same may be said as regards milk. More milk is often given than the child can digest, and decomposition of the proteids takes place in the bowels, and the stools are foul and unhealthy. Five meals a day are enough, the chief meals being breakfast and dinner, and on no account allow food of any sort or fruit or sweets between meals. Let the diet be varied; avoid a one-sided diet.

After the child has entered its third year and has cut all its milk teeth a still more varied diet may be allowed. Bread and milk, oatmeal or hominy porridge followed by brown bread and "bacon drip," or occasionally an egg, may be given. It is a mistake to make the second course too tempting, or the bread and milk will be left but half finished. Sweets in the shape of jam or marmalade had best be left till tea-time. Not much should be taken at eleven o'clock lunch, a biscuit, or a cup of milk is quite enough, and many children do best without. At dinner fresh fish, fowl, or flesh, with cooked vegetables, form the chief part of the meal; the potatoes should be mashed and sieved, and the green vegetables thoroughly cooked; soups and broths may be given for a change. The second course may consist of light puddings and cooked fruit. Rice, sago, tapioca, with stewed apples, pears, prunes, or jellies, are good. All forms of pastry, suet puddings, "trifle," or jam tarts, are bad. Raw fruits, as apples, pears, figs, bananas, should certainly not be given to children of weak digestion; orange and grape juice or pulp are much better. A plain tea is all that is required; eggs, fish, sardines, etc., are unnecessary and of doubtful utility at this meal. Bread and butter, jam, or marmalade, a sponge cake, may be allowed, with milk and water to drink. Avoid rich cakes and jam puffs, tea cakes or hot buttered toast. For supper a cup of cocoa is light and nourishing.

Great stress must be laid on accustoming children to eat slowly and masticate their food, while taking care that their teeth are seen to, and their food, especially butcher's meat, is tender and cut up finely.

It cannot be urged too strongly that eating between meals is physiologically wrong; the stomach requires rest, and is certain to get out of order if too continuously worked.

Encourage tidy habits at meal times and simplicity of living, while providing a suitable variety of foods. Encourage a child to clear up its plate and finish its milk, but do not force a child to take food against its will: a little starvation can do no possible harm.

LITERATURE.—ROTCH. *Hygiene and Medical Treatment of Children.*—ASHBY. *Health in the Nursery.*

Nursing, Training for.

THE occupation of nursing, that is, women fully equipped in the art of caring for the sick, ought now to be raised to the dignity of a profession, and those who have obtained the distinction should, by some adequate process of registration, be protected from those who have had an incomplete training. "The Royal Institution of Registered Nurses" is a step in the right direction, but is not sufficiently comprehensive.

Before 1840 the only available assistance obtainable outside the members of the family circle in cases of illness were the untrained services of a respectable woman who had probably no vocation and certainly no training. The pure "Gamp" type immortalised by Dickens is fortunately now almost a matter of history. The first attempt at training nurses was the establishment, in the middle of last century, of an Association of Nursing Sisters by Mrs. Fry, the celebrated Quakeress. The object was to obtain a body of respectable women with a few months experience in an hospital, who would attend sick people in their homes. She hoped to secure for them fair remuneration for their work, and a small pension after thirty years' service. Miss Nightingale's experiences in the Crimean War gave an impetus to the work by showing the need for nurses. Shortly after this a school of nursing was instituted at St. Thomas's Hospital, London. Most of the hospitals followed this example and started schools, with the object of training nurses and thus affording the public the benefit of their services either in private, district, or hospital work. At the present time so great has been the increase in nursing that almost everyone in a position to pay from 30s. to £2 : 2s. weekly can be nursed by a woman claiming to be fully trained. However, on this point of training the greatest diversity of opinion prevails. For example, any woman can call herself a fully-trained midwife or monthly nurse who has had a brief course of three months' instruction in practical midwifery, and has received a diploma from the London Obstetrical Society. On the other hand, a woman who has after a three years' course of instruction in a general hospital, and thereby qualified as a fully-trained nurse, and has then devoted three or more months to obstetric work, and obtained a certificate, does not rank any higher than the one just referred to. This is surely anomalous. The same may be said of masseurs, certificates—so-called—can be gained by anyone choosing to attend a very short course of lectures and pay a small fee. On the other hand, a certified Swedish masseuse is on a different footing, she will only have acquired a certificate after three to four years' training.

Thus there is as yet no recognised accepted general standard of attainment for certified nurses. Until nurses can be placed on a proper footing, however well trained, and however efficient they be, they can never obtain either the position or pay to which the best are entitled until the medical profession and public have the means of differentiating between good and bad by some other means than pleasant or painful experience.

Before describing the various methods of training that are open to women desirous of becoming nurses, it is well to make it clear that to be a really good nurse one needs the best training available as well as a natural disposition for the profession. Training alone will not transform an impossible nature into that which is required for a good nurse.

Training.—It is much to be desired that we in this country should adopt some such system as that tried in America for some years past, which has been found to answer well. In 1889 a college of nursing was started in connection with one of their medical schools and hospital. In this training institution the probationer nurses receive no pay during the course. A thorough training is rightly regarded as adequate remuneration. A short outline of the course of instruction at one of the institutions which can rightly claim to be regarded as a properly equipped college of nursing is here given.

> The training school for nurses, Baltimore, is an integral part of the Johns Hopkins Hospital, and under the same government. The school buildings are within the hospital grounds, but separate from the hospital buildings. The Johns Hopkins Hospital affords exceptional advantages for the education of nurses. It is a general hospital containing 320 beds, and offering opportunities for a thorough and varied practical experience in medical, surgical, gynæcological, and obstetrical wards.
>
> Instruction in the properties and preparation of foods, and in their application to the needs of the sick, is given in a model kitchen equipped for teaching purposes. Models and specimens, necessary for demonstration in various subjects, are obtained from the Johns Hopkins Medical School.
>
> Applicants wishing to obtain a course of instruction enclose a letter from a clergyman notifying to good moral character and qualifications for undertaking professional work, and from a physician certifying to sound health and unimpaired faculties. No candidate will be considered who is not in good physical condition. Applicants must not be under 23 years, nor over 35, and of at least average height and physique. A preliminary examination will be held to show that they have had a good general English education, and while this is indis-

pensable, applicants are reminded that women of superior education and cultivation will be preferred, provided they meet the requirements in other particulars. The superintendent of nurses and principal of the training school decide on their fitness to work, and have the power to dismiss them at the end of term of probation or during its course if deemed advisable.

Those who pass the examination and are proved satisfactory during the term of probation, are accepted as pupil nurses, and sign an agreement to remain the three years of the course and obey the rules.

Course of Instruction.—The course of instruction covers a period of three years. The first six months of study and practical work is considered a probationary period, and failure to pass the examinations and tests at the end of this time is considered almost invariably a sufficient cause for the termination of the pupil's connection with the school. The arrangement of work and study as outlined below is in pursuance of a definite plan to provide the pupil, before she is brought into contact with her patients, with some fundamental knowledge upon which the art of nursing depends, and without which she is unable to benefit by the practical part of her work.

The subjects are *Household Economics.* This means a careful study of food production, manufacture, and cookery; the cost of food materials, fuels, and cooking apparatus; the nutritive values of foods, their use in special forms of disease, and their special preparation for invalids; the serving of foods and the planning of hospital dietaries. Instruction is also given in the maintenance and administration of the household, including cost and care of furnishings; supplies of lighting and heating; and the plumbing, drainage, etc., of the home and institutional laundries.

Short courses are given in *Hygiene and Sanitation, Anatomy and Physiology.* This occupies a period of about three months with six hours' instruction weekly. *Materia Medica;* this includes a general outline of the properties and uses of drugs.

In addition to these classes, demonstrations are held weekly in which the pupil is taught the simpler practical part of nursing work, and becomes familiar with the various appliances and utensils used in nursing, the preparation of dressings, the care of instruments and materials.

Those who pass the examinations at the end of this period and give satisfactory evidence of a general fitness of disposition and temperament for the work of nursing are placed in the wards of the hospital for further work and study. After entering the wards the pupils spend not less than eight hours daily in practical work under the immediate supervision and direction of the head nurses and assistant-superintendents. They spend one to two hours daily on demonstrations and lectures.

During the first and second years pupils receive instruction and practical work in the medical, surgical, and gynæcological wards, and also an insight in the nursing of infectious diseases and orthopedics. At the same time they have theoretical instruction in surgery and gynæcology, and lectures on infectious diseases, this course including instruction in contagion and immunity. Massage is also taught at this time, and a full practical demonstration in this subject covers a period of two months.

The senior year includes obstetrics, pediatrics, nervous diseases, including the care of the insane, diseases of the special senses. Special instruction is also given in connection with nursing in institutions, in district, and private nursing. The care of invalids and convalescents in connection with providing suitable occupation is also discussed.

Pupils, upon completing satisfactorily the full term of three years, and passing successfully the final examinations, will receive the diploma of the school.

In this country I only know of two hospitals, the Royal Infirmary, Glasgow, and the London Hospital, Whitechapel, where an attempt has been made to institute a system of preliminary training and examination, and this experiment has been attended with the best possible results. The age regulation for commencing nursing in a general hospital being between 23 and 25 years of age, the interval of time beforehand can be profitably filled up by the candidate taking lectures on general nursing, elementary physiology and hygiene, and courses of practical cookery. These classes are obtainable in domestic economy schools and classes throughout the country. With such previous knowledge a probationer nurse's power to profit by ward training is greatly increased.

There is here appended a short account of the present regulations for admission, etc., to general and other hospitals. As has been already indicated this falls far short of the ideal.

The General Hospitals, containing from 600 to 800 beds.—Probationers must be between twenty-five and thirty-five years of age, and after a month's trial can enter for two years' training and two years' service, either in the hospital or on the private nursing staff (some hospitals only require three years' training). Salary: first year, £12; second year, £20. Nurses receive from £24 to £27 a year. The whole or part of the indoor uniform is provided, and some hospitals give the outdoor uniform as well.

There may or there may not be an entrance examination. An examination is held each year, and also at the completion of the course.

All applications should be made in writing to the matron, and in most institutions a personal interview with the candidate is an invariable rule.

Poor-Law Infirmaries.—The age limit is younger—twenty-one to thirty years. Probationers have to put in first three months of trial. If appointed probationers they then engage to remain three years in the service of the infirmary, receiving lodging, washing, and uniform. Nurses receive regular instruction from the medical officers and matron, and must pass certain examinations at the end of the third year, when they receive a certificate. Twelve hours are spent on duty daily, and the various times allowed off duty are less than in a general hospital. In most of the infirmaries the nurses have a comfortable house, and either have separate bedrooms or cubicles. The salaries are: first year, £10; second year, £20; third year, £22.

Children's Hospitals.—Probationers may commence their training at twenty-one years of age. A certificate is usually granted after two years. This certificate is of no value for a later appointment in a general hospital.

Infectious Hospitals.—All inquiries of those about London should be addressed to the Clerk, Metropolitan Asylums Board, Embankment, E.C., and in provincial parts applications to be made to the matron of the infectious fever hospitals.

In fever hospitals, as a rule, the hours on duty are shorter than is usual in the general hospitals.

District Nursing.—Almost all the county associations which endeavour to supply trained district nurses are now affiliated with the Queen's Jubilee Nursing Institute, and the nurses are known as Queen's Nurses. The objects of the general scheme are the training of nurses in the special practice of nursing poor by visits at their own homes; the provision of a continuous supply of qualified superintendents and nurses to local associations in affiliation with the Institute; the ensuring a high standard of district nursing throughout the kingdom by efficient inspection of the nurses' work.

The following qualifications are necessary:—

(*a*) Training in some general hospital or infirmary for at least two years; (*b*) Approved training in district nursing for not less than six months, including monthly nursing; (*c*) Nurses in country districts must in addition have at least three months' approved training in midwifery.

During her training the nurse will receive £12:10s., with board, etc., and allowance for laundry. After training the nurse must agree to serve the Institute as a district nurse for two years wherever her services may be required by the Council. When a Queen's nurse the commencing salary is usually £30, with board, lodging, uniform, and an allowance for laundry.

Applications for training should be made by letter to the Inspector, Queen Victoria's Jubilee Institute for Nurses, St. Katherine's, Regent's Park, N.W. They will then be put in communication with the superintendent of the head branches in London, Edinburgh, Dublin, or Cardiff.

In some rural districts where the associations are unable to afford a completely trained nurse to work in the homes of the poor, an endeavour has been made to meet the need by giving women in the villages an insight into nursing duties as will enable them to give assistance in ordinary cases of illness. This form of instruction has been given to a large number of village nurses at the Plaistow District Nurses' Home, Essex, under the matronship of Miss Twining. The knowledge the nurses acquire during the six months, both as regards district work and midwifery, is wonderful, as far as it goes, but no woman who has sufficient education to pass the preliminary examination in hospital should be content with anything less than a full training qualifying them to take charge of any form of illness.

Midwifery and Monthly Nursing.—The London Obstetrical Society gives a certificate on passing the examination provided the candidate has had three months' training in some recognised maternity institute. Licenses to midwives are granted by the Royal College of Physicians, Ireland, on the candidate having a certificate of six months' training in a recognised lying-in hospital, and being able to pass the examination instituted by the Board. This training is sufficient when taken after a three years' course of general nursing, but is inadequate for the majority of women who go in for this class of nursing without any previous training. The average age is between twenty-three and forty years of age, and the fee for midwifery training is about £26, while that for monthly nursing is generally smaller.

The following is a list of training hospitals :—

Queen Charlotte's Lying-in Hospital, Marylebone Road.
General Lying-in Hospital, York Road, Lambeth, S.E.
Clapham School of Midwifery, Clapham Road, London, S.W.
Maternity Charity, Howard's Road, Plaistow, Essex.
Rotunda Lying-in Hospital, Dublin.

Mental Nursing.—In order to gain a certificate the nurse must pass the examination held by the Medico-Psychological Association of Great Britain and Ireland. The regulations made by the Association for the training and certification of attendants and nurses for the insane are carried out under the supervision of an educational committee. Attendants must have trained for two years at an asylum recognised for the purpose by the Council of the Association before they can enter for the examination. The system of training must include systematic lectures and demonstrations by the medical staff.

A register is kept of all persons who receive the certificate, whose names may be erased, and the certificate forfeited in case of misconduct.

These regulations came into force after 31st October 1900.

LITERATURE.—1. Osborne's *Sick Nursing*, one of the manuals for the employment of educated women.—2. Burdett's *Nursing Directory.*—3. *The Nursing Record*, Nos. 672, 673, vol. xxvi., article, "The American Nursing World."

Nyctalopia. *See* Retina.

Nystagmus. *See* Ocular Muscles.

Obesity.

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Obesity (from *ob*, on account of, and probably *esum*, from *edo*, to eat) is a term applied to an excessive production of *fat* or *adipose matter* which is found deposited especially in the subcutaneous, intermuscular, and subserous connective tissue, the greatest deposits being found in the nates, thighs, back of the neck, the abdominal walls, the omentum and mesentery.

Etiology.—The ultimate fact upon which obesity depends is that more fat-forming substances are taken into the body as food than can be physiologically utilised in the functions of the organism, and the excess is deposited as adipose tissue in the body.

Speaking generally, the obese person is a person who consumes more food, or more food *of a certain kind*, than he can use. But there are many predisposing causes of obesity, and the whole question of etiology cannot be disposed of by the above simple statement. Among the predisposing causes of obesity *heredity* takes an important place.

Oertel states that 50 per cent of the patients who come under observation for obesity have an hereditary tendency thereto.

In these hereditary cases the manifestations of the tendency to excessive deposition of fat is often seen in early life—more commonly in female than in male children. Sometimes it affects all, and sometimes only a certain number of the children of the predisposed family. Sometimes this tendency does not appear till a more advanced age. In this connection Weinberger has reported the case of a boy five years of age weighing over 13 stones, and Kisch a girl of six weighing nearly 8 stones, and we have ourselves seen a boy of eleven years of age weighing over 15 stones.

An important practical consideration with reference to these hereditary cases is that they are much less favourable subjects for therapeutic treatment than are cases of acquired corpulency. Amelioration under treatment in such patients is usually of only temporary duration.

Age.—With respect to the influence of age in causing obesity, it has been observed that advanced middle-age is the period when excessive development of fat is apt to set in. We are leaving out of consideration those normal developments of adipose tissue which occur in infancy and at the period of puberty in the female sex. At these times the fat is observed to be uniformly distributed over the body, giving a general and agreeable aspect of plumpness, but in middle life this excess of fat tends especially to accumulate in the abdominal walls, the omentum, mesentery, pericardium, mediastinum, etc.

One reason why this tendency should appear especially at or about middle age is doubtless because the physiological need of food naturally diminishes with advancing years and a less active life, and the capacity for utilising it diminishes also. Notwithstanding this there is no diminution in the amount of food taken. At this age the capacity for muscular exertion is lessened, and there exists no longer either the same disposition or the same ability to engage in those active physical exercises which in earlier years dispose of much of the surplus food-supply.

Sex.—It is easy to understand the increased incidence of obesity in the female sex. In the first place, there is naturally and normally in women a more extensive and abundant development of adipose tissue than in men. Then their more sedentary and less active habits and their more luxurious modes of life favour the development of obesity. It has also been suggested that their blood is poorer in hæmoglobin, and therefore less able to oxidise the fat-forming substances in their food.

There is a marked relation between the development of fat and the functional activity of the sexual organs.

Impotence or castration in the male is often attended by a rapid increase of fat formation. Castrated animals are known to fatten readily. After the cessation of menstruation in women a tendency to obesity often sets in, and the same has been observed to occur with young widows who have not remarried. An increase of adipose tissue has also been observed in women who have become sterile from uterine or ovarian disease. Monks and nuns often offer notable specimens of obesity.

Temperament.—Persons of the so-called *phlegmatic* temperament, indolent, good-natured, easy-going, as opposed to the *sanguine*, energetic, active, and quick-tempered, and the nervous, fretful, and worrying disposition, are predisposed to the accumulation of fat.

Race and Climate.—It has been observed that obesity is more frequent among Orientals, the inhabitants of southern Europe, Dutchmen, Hottentots, etc. This may be to a certain extent accounted for by peculiar food habits and customs. Some Oriental women purposely consume a great excess of fat-forming food to increase their obesity, which is regarded by them as a great personal attraction. It has also been pointed out that the hot sun of southern climates restricts the physiological consumption of fat in the production of heat, and this leads to a considerable deposition of fat in the body, while "the moist and warm air of the lowlands and wide plains is more favourable to corpulence than the cooler air of the highlands, which requires the combustion of more fat for the production of heat, and furthermore, owing to the formation of the ground, there is the necessity for greater muscular activity in climbing" (Oertel).

If the preceding may be regarded as the chief *predisposing* causes of obesity, the efficient *exciting* causes are the food habits and general mode of life of the individual.

If the regular *intake* of food exceeds the nutritive requirements of the individual an accumulation in the body of fat will follow, and this will be the more pronounced if the excess of food taken consists of such substances as are readily transformed into fat in the organisms, or which serve to economise the consumption of fat within the body.

The carbohydrates and the fatty foods—though the latter in a less degree than the former—are especially prone to favour fat deposition, but it is also certain that albuminous foods are also capable of being converted into fat within the animal body under certain conditions.

Ebstein's statement that fat in the food does not give rise to fat formation has been hotly contested, and Oertel remarks with regard to this view, "It is one directly opposed to all physiological investigations. It has arisen only from a misunderstanding of one of Voit's statements, whose interpretation in Ebstein's sense has been particularly cautioned against by Voit himself, for which reason it may be passed over as unscientific."

Such substances as fat, starchy substances, sugars, cakes, confectionery, and the like, when taken freely tend inordinately to the production and accumulation of fat. Excessive beer-drinking has the same effect, and in a somewhat lesser degree all alcoholic drinks, for they not only tend to promote fatty degeneration, but they also, by being burned up in the body, save an equivalent amount of albumin and fat, and so favour the deposition of fat in the body, just as carbohydrates and fats do. Even the excessive consumption of water favours fat formation. This is a fact recognised by all trainers!

When in addition to excess of food we encounter also habits of indolence—an avoidance of physical exercise and an over-indulgence in sleep—we have present additional potent factors leading to the excessive accumulation of fat in the body.

All these act through a diminution of the normal oxidation processes within the organisms.

Two forms of obesity are generally recognised: (*a*) the *plethoric* form, and (*b*) the *anæmic* form.

(*a*) The characters of the *plethoric* form are too common and too obvious to need detailed description. In the early stage the muscles are large and fully developed, the blood is rich in albumin and hæmoglobin, the bearing and attitude are erect and confident; the pulse is full and strong. Later on, with physical signs of cardiac hypertrophy, the pulse becomes weaker and less frequent, the respiration is hurried on any exertion, and muscular exercise is associated with effort and fatigue. To this stage succeed other morbid conditions to which we shall immediately recur.

(*b*) The *anæmic* form is less common. It is most frequently observed in women, young, delicate girls with pale faces and much adipose tissue. In them the catamenia are usually scanty, irregular, and often painful. Or they may be older women who have had repeated hæmorrhages or endured prolonged lactation, and been fed with unsuitable food.

Or it may develop in men, especially during convalescence from acute disease, and who, perhaps, have been given large quantities of fat-forming food beyond their capacity of utilisation. In all these cases the excessive accumulation of fat depends on the poorness of the blood in hæmoglobin, and the deficiency of oxidation processes dependent thereon. In such persons the temperature is subnormal, the pulse is small and feeble, the heart's action weak, the muscles poorly developed, flabby, and inactive, the surface of the body pale and bloodless. The general energy and mental power of such persons are low, they tire quickly, quickly become breathless, suffer from palpitation, and sleep much.

Such patients do not often eat or drink to excess, but they are often addicted to faulty food habits, partaking freely of pastry and sweets, and avoiding animal food.

Their appetites are usually poor because the digestion is feeble and slow, owing to the hydræmic blood which flows to the digestive organs, and hence it is that in this form of obesity the deposition of fat is never so great as in the plethoric form. The quality of the fat, too, does not seem to be the same as in persons who have become plethoric by the ingestion of enormous quantities of albuminous food, fat, and carbohydrates. While the subcutaneous cellular tissue in the latter is firm and granular, elastic, and hard to touch, in anæmia it appears flaccid, soft, loose, and is readily pinched into folds" (Oertel).

The *pathological relations* of obesity are many and complex. Some are directly due to the pressure and interference with normal nutrition of the fatty deposits amongst the muscular fasciculi of the heart and other muscles. Serious loss of power in the cardiac muscle is thus induced. Some are doubtless due to the same faulty habits of life as have led to the obesity.

Obese persons are well known to bear acute disease and surgical operations badly, their power of resistance to depressing influences is diminished and for this reason, as well as on account of their proneness to such diathetic diseases as gout and diabetes, they are generally regarded as unfavourable lives for assurance, and assurance companies invariably charge an augmented premium in cases of excessive obesity.

When the obese become the subjects of the acute infective fevers they are apt to assume an adynamic form. The cardiac feebleness increases rapidly with the fever, and there is danger of sudden fatal collapse. Again owing to the amount of subcutaneous fat, the heat formed in the interior of the body is with difficulty dissipated, and the risk of fatal hyperpyrexia thereby increased, while such patients bear antipyretic drugs badly.

Convalescence from acute disease is slow and not unattended with danger.

The tendency to cardiac feebleness and degeneration brings with it serious tendencies to pulmonary congestion, emphysema, and bronchial catarrh; nocturnal attacks of cardiac asthma are frequent, and degenerative changes in the coronary arteries are attended with a proneness to attacks of angina pectoris.

The general *arterio-sclerosis* so commonly found associated with certain forms of obesity, and not infrequently accompanied with renal changes of a gouty character, brings in its train the risk of cerebral apoplexy.

An enlarged liver, in part from fatty deposits, and in part from passive hyperæmia due to cardiac debility, is a common accompaniment of excessive obesity. Glycosuria, together with symptoms of gout, are frequently observed, and the obese are notoriously prone to calculous deposits in the kidneys and gall-bladder.

This list by no means exhausts the catalogue of morbid changes to which the obese are prone.

TREATMENT.—*Prophylaxis.*—It may be desirable, in dealing with children who inherit a predisposition to the plethoric form of obesity, to attempt to counteract this tendency by a careful regulation of the diet, excluding from it, so far as practicable, all fat-forming substances. It would be well for such an infant to have a wet-nurse who is known to have no such inherited predisposition, or if suckled by the mother, to see that the mother's diet is freed from all excess of fat-producing food, and especially from beer. The same observations will, of course, apply to the nurse. If the infant is hand-fed, then sterilised milk should be used to the exclusion of all other kinds of food.

If after the period of infancy there is still a marked tendency to the overproduction of fat, we should diminish as much as possible the carbohydrates, and butter and foods prepared with fat. We should attend also to the child's general health by inculcating habits of healthy exercise in the open-air. Encourage the practice of gymnastics, carefully adapted to the age and strength of the child, and apply whatever other tonic measures may seem expedient to promote a vigorous and healthy action of the organs of circulation.

During the period of growth and development we must watch the nutrition, and we must be especially careful not to reduce the amount of albumin in the body by too great a reduction of fatty substances in the diet, lest by so doing we should retard or diminish muscular development. Gymnastic exercises may be encouraged if they are carried out with judgment and moderation.

In the *anæmic* form be on the lookout for signs of anæmia in infants, and give suitable preparations of iron (such as the compound syrup of hypophosphites), and establish a dietary having for its object the regulating of fat and albumin formation.

Later on gymnastic exercise may be recommended, carefully adapted to the muscular development and capacities of the child.

In scrofulous cases the saline and chalybeate mineral baths may be useful, or cold ablutions and frictions with sea-water once or twice a day, so as to stimulate powerfully the circulation and increase the power of resistance of the surface to external injurious influences.

Dietetic Treatment.—In applying a dietetic method of treatment to cases of obesity each individual case should be made the subject of close study and analysis. In the first place, the patient's weight should be accurately noted.

A physical examination of the patient should be made, especially with the object of ascertaining the condition of the heart and arteries, the condition of the lungs and liver, and that of the kidneys by the examination of the urine.

We should ascertain whether we have to do with a case of the hereditary or acquired type. An accurate account should be obtained as to food habits, the amount of exercise and sleep taken, and the nature and amount of daily work. The previous history may reveal evidences of gout and glycosuria. It is desirable also to ascertain the average daily output of urea, as any deficiency in this respect in relation to the food taken would counter-indicate a highly nitrogenous dietary.

If, as the result of our examination, we find we have to do with a vigorous person whose organs are sound, we may apply a much more rigid dietary than to one whose health has broken down, and whose organs are more or less diseased.

If we have to do with a case of the plethoric form we shall certainly have to reduce the *quantity* of food taken daily. As there is scarcely any form of food from which fat cannot be formed, a reduction in the *total quantity* is of the first importance.

The quantity of food absolutely necessary to maintain the nutrition of the body varies greatly in different individuals, and depends chiefly on body weight, age, and activity. It has been calculated that a healthy adult requires daily from 100 to 130 grammes of proteids, 450 to 550 grammes of carbohydrates, and 40 to 80 grammes of fat; to these must be added 30 grammes of salts and 2800 grammes of water. These figures may be much reduced if the patient is kept at rest in bed, at any rate for a short period.

We recently had to keep a stout, active patient suffering from chronic gastric ulcer on a limited milk diet while resting in bed for some time. For the first week he only had 36 oz. of milk daily—3 oz. every two hours—he was perfectly satisfied and comfortable, and did not wish for more. A little more food (an egg or its equivalent) was then added. At the end of a fortnight he had lost nearly two stone in weight, and at the end of three weeks he was able to take a fair amount of exercise, feeling lighter and stronger than he had done for some time. With a careful diet—limited, but sufficient—this loss of weight has been maintained. Absolute rest in bed is, however, needful whenever a very restricted diet of this kind is applied. But we see no reason why this very restricted diet should not be more frequently applied to the reduction of body weight in suitable cases, and when the cordial co-operation of the patient can be relied upon.

Prof. Débove, last year, presented to the Académie de médecine of Paris a man 55 years of age, who weighed on admission to Hospital 234 pounds, and after a year's treatment weighed only 180 pounds, the remedy employed being a very severely restricted milk diet. There was some hereditary predisposition to the malady. He had been growing fat since the age of 25. He was of sedentary habits and given to alcoholic indulgence. He suffered also from gravel and gout, and had become impotent.

In considering the means available for reducing his obesity, Débove discarded preparations of the thyroid gland, the protracted use of which be considered dangerous, and the beneficial results only temporary. Active exercise could not be prescribed, as the man could not leave his bed. He chose, therefore, the only method he thought practicable, viz. by giving the patient an insufficient amount of nourishment to oblige him to consume his own fat.

He was put on an exclusive milk diet, the quantity of milk being severely limited. During the first month he had two quarts of milk a day, during the second month one and a half quarts, and during the third month one quart only. He lost 27 lbs. the first two months, and 4 lbs. the third month. During the four following months the patient took *less than a quart of milk* a day, and his weight finally fell to 180 lbs.. He was at the time of the report in perfect health.

This is a remarkable and most instructive instance of the small amount of food upon which existence can be maintained and excess of weight thereby reduced without injury to health, provided the patient be kept at rest in bed. Weir-Mitchell has also warmly advocated a restricted milk diet for the reduction of obesity.

It will be found, in examining the various dietetic methods that have been advocated for the treatment of obesity, that they all aim at reducing the average quantity of food taken.

The *carbohydrates* are especially attacked in all, and they are largely reduced. There would seem to be a far greater tendency to excess in this class of food than in the other classes. This is probably due, in some measure to the great convenience and cheapness of such food as, *e.g.* bread and butter, biscuits, sweet cakes, etc. ; such foods are always at hand, they require no preparation, and they are agreeable to the palate.

In some of these methods an *excess* of proteids is prescribed; this excess has been considered to favour the reduction of obesity by promoting the oxidation and combustion of the excess of deposited fat.

In nearly all these methods a strict limitation of the amount of liquid taken is insisted on, and one of the earliest systematic methods advocated for the cure of obesity was to prescribe as *dry* a diet as possible. By prohibiting all drink during meals no doubt the desire to take a large quantity of food is diminished. The work of mastication is made slower, and mastication and insalivation must be more complete or there would be difficulty in deglutition. In the case of large eaters with vigorous digestion, this method of eating *dry* is no doubt an efficacious one, but in certain other cases a full supply of water is needed, and especially in gouty cases, to promote complete digestion and to favour the elimination of waste products.

The two principal objects aimed at in all these methods is, first, to cause the obese person to consume the excess of fat deposited in his body by restricting the food-supply, or by augmenting its combustion by increased physical exercise or other means; and, second, to establish a dietary which shall prevent its re-accumulation.

We may take Oertel's method as a typical one, and one which has been very generally adopted. He claims for his system that it not only provides for the removal of fat, but also prevents its re-accumulation; that it also maintains the amount of albumin, and restores tone to the organs of circulation. He distinguishes two degrees of obesity: one, the slighter form, in which the organs of circulation are unaffected and vigorous bodily exercise is possible; and another, the graver form, in which the muscle of the heart is invaded and weakened, and other functional derangements connected therewith are developed. He adopts Voit's statement that the human body decreases in fat if the daily food consists of the three great groups of foods in the following proportions:—

Proteids about 4½ oz., fats 1⅝ oz., and carbohydrates about 5⅛ oz. Oertel therefore, allows 5½ to 6 oz. of proteids, 1 to 1½ oz. of fat, and 2½ to 3½ oz. of carbohydrates. With this diet regular exercise is combined, as muscular exertion is attended with a considerable reduction of fat, and the relative excess of proteids in this method leads to the displacement of the fat accumulated in the substance of the muscles and to a new formation of muscular tissue in its place. At the same time, this diet protects the nitrogenous tissues from waste.

In the graver cases, where the accumulations of fat about the heart has led to great embarrassment of that organ, and to consequent visceral congestion and even dropsy, the fats and carbohydrates are still further reduced, and the amount of fluid consumed is severely restricted, and the fluids of the body are further reduced by vapour and other baths.

In this dietary the proteids may consist of roast or boiled beef, veal, mutton, game, and eggs. Green vegetables, such as cabbage and spinach, may be taken; fat in very limited amount; bread, 4 to 6 oz. per diem. The fluids taken daily must be limited to rather less than 6 oz. of coffee, tea and milk morning and evening, and about 12 oz. of wine with from 8 to 16 oz. of water. Beer is, of course, forbidden.

This method may be put into actual practice in the following manner:—

Morning.—One cup of coffee or tea with a little milk—altogether about 6 oz. Bread about 3 oz.

Noon.—3 to 4 oz. of soup, 7 to 8 oz. of roast or boiled beef, veal, game, or not too fat poultry.

Salad or a light vegetable.

1 oz. of bread or farinaceous pudding—never more than 3 oz.

3 to 6 oz. of fruit (fresh preferred) for dessert.

It is advisable at this meal to avoid taking fluids, but in hot weather, or in the absence of fruit, 6 to 8 oz. of light wine may be taken.

Afternoon.—The same amount of tea or coffee as in the morning, with about 6 oz. of water; an oz. of bread as an exceptional indulgence.

Evening.—One or two soft-boiled eggs, 1 oz. of bread, and perhaps a small slice of cheese.

Salad and fruit, 6 to 8 oz. of wine with 4 or 5 oz. of water.

In Schweinger's modification of this method there is an entire suppression of beverages at meals. Whatever fluid is drunk must be taken an hour or two *after* food.

Von Noorden's method, more recently published, differs from the preceding in giving small meals at frequent intervals, *e.g.* :—

8 A.M.—Cold lean meat, 3 oz.; bread, 1 oz.; a cup of tea or coffee with a spoonful of milk, no sugar.

10 A.M.—An egg.

Noon.—A cup of strong soup without fat.

1 P.M.—A small plate of clear soup (Julienne); lean meat or fish, 5 oz.; potatoes, 3½ oz.; green vegetables; fresh fruit, 3½ oz.

3 P.M.—A cup of black coffee.

4 P.M.—Fresh fruit, 7 oz.

6 P.M.—A glass of skimmed milk.

8 P.M.—Cold lean meat, 4½ oz., with pickles; Graham bread, 1 oz; two or three spoonfuls of fruit cooked without sugar.

Some of those who affect to be specialists in the treatment of obesity have been in the habit of applying some modification of the so-called Salisbury cure, the essential idea of which is to limit the food and drink to the lean of meat, preferably beef, and an abundance of hot water.

The late Dr. Towers Smith was a strong advocate of this method, and he has stated that his custom was to give 3 lbs. of rump steak and 1 lb. of cod-fish, together with 6⅓ pints of hot water, as the daily diet for the first fortnight; for the next three weeks 4 pints of hot water with other kinds of lean meat and fish are allowed, as well as a little green vegetable and unsweetened rusks. For the following months the hot water is reduced to about a pint a day and some crusts of stale bread, captain's biscuits, grilled meat, or poultry or game of any kind, and hock and claret with seltzer water are allowed. Five grains of bicarbonate of potash are also prescribed night and morning.

No doubt some striking results in the reduction of fat have been observed to follow this method, which may be accounted for by the supposition that the patient supplies the necessary fat and carbohydrates (absent in his diet) from his own store—that he consumes his own fat.

Thyroid extract and thyrocol, which professes to be the active principle of the thyroid gland, have been put forward as most efficient agents in removing superfluous fat.

Opinion is much divided on this matter. Some experienced observers think them dangerous; others think them valuable in carefully selected cases. Others have found them useless, and think they should be reserved for such cases as do not yield to dietetic treatment, and that then they should be given with great caution because of personal idiosyncrasies.

Their effects seem to be only temporary. It is certain that they cannot safely be substituted for dietetic treatment, nor should they be used as a concession to patients who resent a too strict control of their habits. Toxic effects resulting from this treatment are reported in the *Brit. Med. Jour.* 25th May 1901, p. 1315.

Treatment by mineral waters at such spas as Carlsbad, Marienbad, Kissingen, Brides-les-Bains, Tarasp, and certain others, is popular, and we think it a good way of beginning dietetic treatment in the plethoric, but it is only of temporary value unless supplemented and reinforced by regular treatment, by diet, and exercise afterwards.

Obesity is essentially a dietetic disease, and it is only by dietetic measures that it can be cured. What these measures should be must depend on the application of general physiological principles to the special circumstances of individual cases.

Adiposis Dolorosa.—In 1892 Dr. Dercum presented to the New York Neurological Association the histories and photographs of three cases of an affection which he proposed to term *adiposis dolorosa*, a disease which he considered had not been previously recognised. He has subsequently described this affection in the *Reference Handbook of the Medical Sciences* (Supplement). A case has also been reported in the *Brit. Med. Jour.* by Dr. Hale White (2nd December 1899).

The cases of this disease therein referred to differ entirely from ordinary cases of lipomatosis, and present nervous symptoms which are regarded as possessing a special significance.

One of the distinguishing characters of these cases is that the swollen and fatty infiltrated tissue makes its appearance in a very singular manner. The soft nodules are at first deposited in one spot, or sometimes in corresponding spots in both arms or in both legs. For a time this deposit is limited to the original areas, but later on it appears elsewhere and may spread extensively. Some regions may, however, remain permanently free from invasion.

In one case the deposit appeared first in both upper arms, then on the back, then on the inner aspect of the right knee, then (some months later) on the corresponding aspect of the left knee, and still later on in various other situations. But the legs below the knees remained permanently free, and the thighs and buttocks were but little affected.

In another case the swelling began on the inner aspect of both knees, and gradually spread unequally over the thighs and buttocks; later on it involved the left arm, then the sides and back, and finally the entire trunk.

In a third case the masses, which were distinct and separate, appeared first on the back of the neck, and at different periods spread to other parts. In this case the face, fore-arms, legs, thighs, and buttocks remained free from deposit.

Another peculiarity in these cases is that the swellings are accompanied at some time or other with *pains* or other *nervous* symptoms. "Pains, shooting, burning, or stabbing in character, were present in all these cases at various times in their histories." Tenderness over the nerve trunks has been observed during the early or developmental period.

Other nervous symptoms noted were diminished cutaneous sensibility and patches of anæsthesia, excessive debility, absence or diminution of perspiration, and headache. Other symptoms observed were hæmorrhages, gastric, nasal, or uterine, and in one case well-marked purpura.

Microscopic examinations of fragments of the swollen tissue removed by the Duchenne trocar showed fat cells and connective tissue in varying proportions—the latter appearing "decidedly embryonal in type."

A most important fact was that in two cases on post-mortem examination the *thyroid* was found indurated and much infiltrated by calcareous deposit.

Dr. Dercum points out that the thyroid should be studied in every case of obesity that reaches the post-mortem table. He concludes that these cases cannot be regarded as cases of simple obesity, nor are they cases of myxœdema,—of the latter they lack the peculiar physiognomy, the spade-like hands, the infiltrated skin, the peculiar slowing of speech, etc. He thinks they are cases of "connective tissue distrophy, a fatty metamorphosis of various stages of completeness, occurring in separate regions, or, at least, unevenly distributed and associated with symptoms suggestive of an irregular and fugitive irritation of the nerve trunks, possibly a neuritis." It remains for future research to determine to what the neuritis is due—whether it is the cause of the fatty metamorphosis or only a concomitant, and whether *the thyroid gland does not play some mysterious part in its causation.*

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See also STRABISMUS.

In connection with pathological conditions of the external muscular apparatus of the eye there are three chief possibilities, viz. an abnormal position or development of one or more of the muscles, involuntary action of the muscles (nystagmus), and partial or complete paralysis of one or more of the individual muscles.

1. Abnormal Position or Development of one or more of the Exterior Ocular Muscles

It is a state of matters not so very infrequent that the two eyes, apart from the condition properly termed squint, are not precisely directed when completely at rest to the same point in space: that the two visual axes are not parallel, but are falsely directed in reference to one another. This condition to which we refer at present differs from true squint in the first instance in two important particulars, viz. that it is congenital, and that it has no relation to the refractive condition of the eyes. There are three possibilities: that one eye may look higher than the other, a condition expressed by the term right or left hyperphoria; that one eye may tend to deviate inwards or outwards from its neighbour, called esophoria and exophoria respectively (right or left); and that whether alone or in conjunction with one of the other conditions, the vertical axis of one cornea may be rotated towards the other either above or below. It must be manifest that, given fairly equal vision in the two eyes, and the desire for binocular vision, it is quite possible that the constant effort required to neutralise the inconveniences of the faulty position may give rise to grave discomfort. Thus, if when the eyes are quite at rest their visual axes tend to cross, the patient, unless he incessantly keeps one or both of his external recti actively innervated, will be apt to have double vision. This constant struggle will be bad enough in the case of the external or internal recti, but these are comparatively powerful muscles; it is when height differences are present that the chief trouble exists. If in order to keep the images of one object upon the two maculæ at once the patient requires constantly to pull down one cornea he will very soon experience much fatigue. This is easily proved by experiment, for while one can read for some time without much inconvenience from wearing a 3° prism with its apex either in or outwards, he cannot endure for any length of time a prism even of 2° apex upwards. Such faults of position as we are now speaking of arise from congenital imperfection or malposition of certain of the muscles. One may readily suppose that if the superior rectus muscle of the right eye is inserted a little too far forwards or too nearly above the vertical meridian of the cornea, or if one of the "upward movers" of the left eye be imperfectly developed, a condition of right hyperphoria must exist; and here one must point out an error into which it is easy enough to fall. It is not to be supposed that because on inspection a patient's right eye stands at a manifestly higher or lower level than his left he therefore has hyperphoria. That is incorrect reasoning, for if his visual axes be but parallel, he might have his two eyes one above the other instead of side by side without having hyperphoria. We must not judge by the mere position of the cornea, but by the direction of the line of vision, a totally different thing.

For the discovery of those forms of malposition of the eyes one requires certain tests, which are more refined than those which are sufficient for the display of diplopia produced by actual paralysis of a muscle. To describe even a proportion of the instruments devised for this purpose, the majority of which are employed by no one save the inventor, would occupy many pages, but, fortunately, it is not necessary to do so, for the very simple test devised by Maddox is more reliable than any of the more complicated apparatus. The point is this, that the desire for fusion, for binocular vision, tends to mask and to prevent the double vision which is constantly threatening, and, as one might say, attempting to occur. If it were not so the patient would suffer no inconvenience; it is just this effort to fuse against difficulties which causes all the trouble. Dr. Maddox's plan is to render the image which falls upon one eye so unlike that which falls upon the other that the patient will not realise that they are the two images of one object, and so will not attempt to fuse them; we shall thus find out, by their relation to one another, what is the position of the two eyes relatively to one another. He accomplishes this by the simple expedient of causing the patient to look at a spot of light (a gas jet turned low will do nicely), while before one eye is held a glass rod or bundle of rods. The eye before which the rod is held sees the light in the form of a streak running perpendicularly to the axis of the glass rod, and according as we hold the rod the patient can readily tell whether the line of light is to right or to left, above or below the gas jet, through which of course it ought to pass. The degree of error is easily read off on a scale on the wall, in the centre of which the gas or candle is burning.

Another simple and useful plan of discovering latent convergence or divergence is to cause the patient to look steadily at a dot, through which passes a fine line drawn vertically on a sheet of paper. The two images are separated by placing before one eye a prism with its apex upwards or downwards, when, should no divergence or abnormal conveyance be present, the line will be merely lengthened, and show two dots, but if either of these conditions exists the two images will be laterally as well as vertically separated.

As regards the actual harm done by such minute abnormalities and their frequency there are great differences of opinion: many surgeons, especially in America, holding that they are quite a frequent cause of the most widespread and varying bodily symptoms, such as epilepsy, chorea, and insanity, while others consider their influence in such matters to have been greatly exaggerated. Two points especially call for remark, namely, that it is quite certain that many persons have errors of this nature which never give them the smallest uneasiness, and that *occasionally* one meets with a case in which such an error really does cause headache or similar discomfort. The general opinion on this side of the Atlantic is not in favour of so frequent interference with minimal degrees of error by tenotomy, whether "graduated" or not, as appears to be considered good practice in America. Be the reason what it may, we do not meet with cases which on account of bodily ailment call for interference by operation, with anything approaching the frequency which seems to rule in the United States, at least if one may judge from the writings of certain authors.

The various abnormalities which may in this way occur are spoken of a hyperphoria, when one visual axis makes an angle in the vertical sense with the other, as exophoria when there is divergence, and as esophoria when there is convergence of the axes. These may in any case be combined, and indeed when present very often are combined into hyperesophoria or hyperexophoria. The treatment of such conditions may be either palliative or more radical; the former consisting in the adaptation of prismatic lenses (combined if necessary with convex or concave spherical and cylindrical lenses), so placed and of such power that they shall negative the influence of the incorrect position of the eyes. Thus in a case of hyperphoria it may be necessary to cause the patient to wear a prismatic glass with its apex upwards before the offending eye. All prismatic glasses must of necessity be heavy, for which and for other reasons it is desirable to spread the effect over the two eyes. Thus a patient with right hyperphoria, to correct which he would require to wear a prism of 4° apex up before the right eye, can attain the same result by wearing before each eye a prism of 2°, the apex up in the case of the right, downwards in the case of the left eye. The case becomes more complicated when one has to do with a combined inward-and-upward or outward-and-upward defect, but it is worked out on the same lines. One has simply to discover first the amount of vertical deviation, and correct that by a prism, then similarly with the lateral deviation and the strength of prism required for that, then to combine these two prisms, one with its apex upwards, the other with its apex outwards or inwards, as the case may be, into one simple prism whose apex is in a direction intermediate between those. In a few cases it is good practice to correct the vertical defect by a prism in the vertical sense before one eye, and the lateral defect by a prism in the horizontal sense before the other. It should also be borne in mind, that a patient will very readily, in most cases, overcome by muscular action a small lateral defect, provided the vertical error is artificially corrected for him by a prism. In any case in which the refractive error is large and the position error small, one may attain one's end without prisms by means of decentration of the convex or concave lens which the patient requires (see Maddox). This palliative method is applicable only in those cases of malposition of the eye, congenital or acquired, in which there is distinct desire on the part of the patient for binocular fixation, and we shall have occasion to revert to the subject when speaking of the treatment of paralytic strabismus; it is not applicable except when the amount of error is slight.

The radical methods of treatment consist in operation upon the muscles, either in the direction of diminishing the power of the muscle which is relatively too strong (tenotomy), or of increasing the power of a direct or indirect antagonist (advancement). To this matter we shall revert when speaking of paralytic strabismus. (See also " Concomitant Strabismus.")

NYSTAGMUS

In NYSTAGMUS we have to deal with a peculiar condition of the ocular muscles in which there is involuntary movement of the eyes. This movement practically always (though there are rare exceptions) affects both eyes, though not invariably to the same degree, and, according to circumstances, may be in (1) a vertical, (2) a horizontal, (3) a rotatory, or (4) a mixed sense. An important feature of nystagmus, and one which has an important bearing upon its etiology, is that, with a possible exception to be mentioned presently, the movement of the two eyes is invariably conjugate, that is, that both eyes move upwards or downwards, or to the right side, or to the left side, or are rotated like the hands of a watch, or in the contrary direction to the hands of a watch, at the same moment. The way in which this very important fact may be most simply stated, and the manner of stating the fact which most clearly shows this point in the etiology, is to say that the movements take place as they do in the normal eye; they occur as voluntary movements do, being due to outflow of nerve impulses from the centres, and are in this sense only muscular manifestations of nervous excitations. Thus when rotation of the upper half of one eye to the left occurs, the upper part of the other cornea is also turned to the left; while had this been due to a truly muscular lesion, then the muscles of the left eye which one would have expected to act along with the superior oblique and the superior rectus (producing rotation to the left) of the patient's right eye are clearly *not* the inferior rectus and inferior oblique (producing rotation to the left); yet this is actually what does occur. Except, perhaps, in the case of miner's nystagmus, we are quite ignorant what factors they are which decide the question in which precise direction nystagmus shall occur, whether vertical, rotatory, or what not. In the case of miner's nystagmus, however, the symptom is no doubt due to persistent fatigue of certain definite muscles or of their nerve centres, and the normal action of these muscles gives us the key to the nystagmus. Suppose, for example, that in the course of his work the miner has to lie much upon his left side and look up (to his right), lateral nystagmus will be the result. The exception which I have noticed to the otherwise constant rule that nystagmus is conjugate is in the case of the curious disease known as head-nodding in children, in which class of patients I have certainly seen the movements to be those of convergence and divergence, and of double contraction of superior recti followed by relaxation. Probably the cause of this curious symptom in a little known disease may be a condition of irritation of the nuclei on the floor of the fourth ventricle.

The rapidity of movements in nystagmus varies within very wide limits, as also does the extent of the excursion. Thus in one case one may have to do with a vibration so minute as to be hardly visible, except in the ophthalmoscopic picture, and as rapid as sixty or one hundred, or even many more times per minute, while in another case the excursions may be large, extending from one canthus to the other, and only so frequent as ten in the minute. It may be laid down as a rule that vertical, and I think rotatory, nystagmus is always rapid, while lateral nystagmus may or may not be slow. It may also be said in general terms, though the rule must not be supposed to hold good for all cases, that nystagmus arising in childhood, and where vision is good or fairly good, tends to show great rapidity of movement, while nystagmus acquired in adult life, and where vision is nil, tends to be slow.

The causes of nystagmus are twofold, since they are originally dependent either upon a visual or a motor anomaly. In regard to the visual causes we find considerable divergence, but we have either a cause operating very early in life, perhaps even in utero, and producing a defect of vision which may be severe, or may be or become quite slight, or (2) a cause operating later in life and associated with very grave defect or total loss of sight. Thus, under this heading, nystagmus may occur either because the patient has never had proper vision, or because he has had it and lost it. For its production in infancy, it is necessary that there has been some influence at work which has prevented the formation upon either macula of images which are more clear or more capable of accurate appreciation than those formed on other portions of the fundus. It would lead us too far from our present subject to discuss at how early a period an infant learns to direct the macula upon a bright object, but it is certainly a matter of not many weeks. The bearing of this point is that it is at an extremely early period that macular vision becomes superior to more peripheral vision, and if nystagmus is to be set up, the cause must be at work before this brief period has passed. No doubt, by that time the macula even is but poorly developed, and its superiority to the rest of the fundus but slight, yet the mere fact of fixation means that already the macula is not merely potentially, but actually, the most acutely perceptive point of the retina, and already the centres have been educated so to direct the globes that images may fall upon these two spots. If, therefore, a damaging, but not completely destroying lesion is to produce nystagmus, it must not merely be bilateral, but very early also. Such a lesion may take various forms; it may be a damage to the optic nerve, showing itself in later life as an atrophy, and probably being at the moment of the nature of a retrobulbar inflammation, or a choroido-retinitis leading to disturbance or destruction of the pigment layers at the centre; or a rather high degree of congenital cataract; or an ophthalmia neonatorum, with ulceration of the cornea and consequent formation of opacities. There may be, in fact, a lesion which prevents either the formation or the appreciation of superior macular images, but whatever it be, the lesion must be early and bilateral; a unilateral lesion is not sufficient, it may cause squint, but will not give rise to nystagmus. It is probably to this class that the nystagmus of albinism belongs.

From the visual side it requires a much more serious lesion to produce nystagmus in the adult than is sufficient in the child, and we see it best marked in such cases as the very bad varieties of retrobulbar neuritis and in atrophy. We never see nystagmus produced in adult life, for example, by even ripe cataract, nor by even fairly severe destructive ulceration of the cornea unless vision is practically entirely lost. In this variety of nystagmus it is that one sees the best examples of the slow, "searching" nystagmus, which sometimes takes a peculiar form. In this the lateral movement in one direction is saltatory, the eyes passing from near the one canthus to near the other in a series of jerks, and return in one long sweeping movement. The writer's impression is that the jerking movement is apt to be from left to right, while the sweeping movement is more usually from right to left; this fact, he is of opinion, may be related to the habit of movement acquired in reading.

From the muscular point of view we have three principal varieties to deal with: miner's nystagmus, paretic muscle nystagmus, and that connected with spinal and cerebellar lesions. In regard to the first of these, we have combined the three evil influences of general bodily fatigue, local fatigue, and insufficient illumination. The rapidity of movement is usually great in miner's nystagmus, and it may be only to be elicited by causing the patient to assume his particular trade-position or to look upwards. Convergence to a near object is vastly more difficult when the object is above the level of the eyes, as it often may be in colliery work, in which case it may be overlooked in the course of an examination not sufficiently minute. In the nystagmus of paretic muscle we see the following condition sometimes:—A muscle has been paralysed, but is perhaps recovering, but on getting the patient to look steadily to an object, so held as to necessitate the weak muscle being kept actively innervated—presently the eye will begin to make slight oscillatory movements, which are apt to become more marked than at first. It is exactly analogous to the tremulousness of one's hand after carrying a weight, and is not of any great importance clinically. The lesion of the cord most frequently connected with nystagmus is disseminated sclerosis, though it occurs with others also. This, it must be carefully noted, has no connection with any visual lesion; there may be troublesome nystagmus while yet the vision is as good as ever it was. In the muscular nystagmus the patient is apt to suffer from an annoyance from which he is free in the case of either infantile or other "visual" forms, namely, the apparent movement of the object looked at as the image falls upon different nerve terminations with the unstable condition of the eyes; this is apt to give rise to much annoyance to the patient.

The treatment of nystagmus resolves itself into the treatment of the original cause of the instability rather than of the condition itself. Sometimes this is simple enough. Thus, in congenital cataract, should nystagmus be developing, operation should at once be performed so as to allow of the macular placing of images. If this can be accomplished so that the patient can learn to fix even one macula upon the object looked at, the development of nystagmus may be checked. Similarly, in cases of ophthalmia neonatorum we are sometimes obliged to perform an optical iridectomy in a very young patient, in order, in this way, to prevent the permanent establishment of instability of the eyes. In the case then of infantile nystagmus, should the cause of the defective sight be amenable to treatment, to attack it is to attack the nystagmus. In the case of miner's nystagmus, and those of this class, the patient must at once, and for good, relinquish the work which is producing the muscle-fatigue from which this results. The first essential is to have the patient to work in daylight, and out of the necessarily constrained attitudes essential in coal-getting. Beyond this, and attention to sobriety and the general health, nothing is required. The prognosis is good provided health be sound, the case is caught early, and the objectionable work given up. Sometimes the patient comes to one while yet nystagmus arises in certain positions *only*, and when that is the case the prospect of improvement and cure is manifestly much brighter than when nystagmus has come to exist in any and every attitude. No direct treatment is called for in the cases of spinal and cerebellar nystagmus, nor in those of the slow nystagmus from blindness. In many children with "causeless" nystagmus from infancy, that is, nystagmus with no visible change in the fundus or media, there is a distinct tendency to self-cure, and as years pass on, the constancy, rapidity, and excursion of the nystagmus all diminish, even to vanishing point. As regards prognosis and treatment in the nystagmus associated with head-nodding in children, see article on that subject.

PARALYSIS OF OCULAR MUSCLES

Paralysis of one or more of the ocular muscles is very far from being an uncommon condition, and it is one which from several points of view demands careful attention; for one reason, the double vision to which it may give rise is not infrequently one of the very earliest symptoms which force a patient in the earlier stages of serious and, it may be, acute intracranial or spinal disease to seek skilled advice; for another, the inconvenience and discomfort to which it gives rise, and the deformity caused, are matters of grave importance to a patient. The immediate cause of our being consulted by a patient whose muscular apparatus is thus thrown out of gear is in the vast majority of instances the occurrence of double vision Now, in order to answer the question which meets us at the outset of our inquiry into these matters, viz., Why does a person whose (say) left external rectus muscle is paralysed have diplopia? we must first of all understand why with two normal eyes one sees singly. There is, as a matter of fact, no more reason why one should see double normally because he has two eyes, than that he should hear the same sound twice over because he has two ears, indeed rather less, but in regard to this matter of single binocular vision there are two theories, neither of which is entirely satisfactory for all circumstances, though both are useful. According to the first theory, all over those portions of the retina of one eye, images falling upon which impinge also on that of the other eye, every individual spot on the right retina has a corresponding point on the left, the fibres leading from which join, presumably at the chiasma, and proceed together to the centre of vision. Impressions falling upon what one might call the duplicated terminal of the central cell are received as one only. The second theory has reference to the muscles, and is to the effect that, according to the precise amount of innervation which is required, or which would be required, to enable the macula to receive an impression of any object, do we judge of its precise position in space; if each eye would require the same degree the object is mentally referred to the same spot,—is seen singly, in other words. On either of these two suppositions the occurrence of double vision when a muscle is paralysed is easily enough explained, for, according to the first, the two images of the one object fall upon non-corresponding points of the right and left retinæ, and are therefore interpreted as two; while according to the other, the suffering eye is erroneously believed to be gazing in a direction other than that which in reality it has adopted; the position, then, of all objects seen by that eye is incorrectly judged. Let us take again the case of paralysis of the left external rectus; on account of its insufficient action, the eye looks more towards the right side than the patient supposes it to do, he therefore refers all objects seen by it to situations farther to the left than those which they really occupy. The muscular-sense theory is the more satisfactory of the two. In regard to the symptoms produced there are three chief points to be considered; not that these are by any means distinct from one another, for they are but different views of the same fact, but as a matter of convenience merely; these points are squint, double vision, and faulty projection.

1. SQUINT.—In a well-marked case of paralysis of either of the major lateral-movers of the eye, strabismus is, at least in certain positions, sufficiently obvious. To take again our old example, in paralysis of the left externus, the left eye, since the weakened muscle is incapable of pulling it to the left, stands in a position of over-convergence; the patient has an obvious convergent strabismus. Manifestly, the degree of squint will vary, other things being equal, with the degree to which the affected muscle is called upon to exercise its function of moving to the left, and fails to do so. When the patient looks to his right hand side, since in that position the external rectus is not called upon to act, the squint will be non-existent, but in proportion as the patient is called upon to look more to his left the squint will be present in ever-increasing degree. Herein lies the essential difference between concomitant strabismus and paralytic strabismus; in the former (which see) the squint is equal in degree all over the field of fixation, while in that at present under consideration it varies with every alteration of the position of the fixation object. In the cases of the internal and external recti squint may be obvious, but when one has to deal with paralysis of any of the other muscles he is forced to rely for diagnosis on other considerations.

2. DOUBLE VISION, in some part or other of the field of fixation, exists in any case of paralysis of one of the exterior muscles, provided that the patient has sufficient intelligence to perceive it, that the vision of each eye is at least fair, and that the deviation of the suffering eye is neither so minute that the separation is not perceived, nor so excessive that the picture falls upon a very peripheral portion of the retina, and so does not impress itself upon the notice. It is by means of the position and character of the diplopia induced that one is enabled to decide, as a matter of practice, which muscle is involved in the great majority of cases.

In order that the practitioner may be able to do this, it is absolutely essential that he should have at his finger ends precise knowledge of the physiological action of each of the exterior muscles of the globe. A very brief note of these must here be given. The external and internal recti have simple actions; they turn the eye, or, to speak more correctly, the cornea, outwards and inwards respectively. Each of the other muscles, however, has a triple action; it moves the cornea either upwards or downwards, and either outwards or inwards, while at the same time it so draws upon the upper or lower half of the cornea as to rotate the upper extremity of its vertical meridian either inwards (towards the nose), or outwards (towards the temple). The superior rectus, being inserted rather to the inner side of the vertical meridian of the cornea, not merely turns the cornea upwards, but in virtue of its position is able to act in this manner to the best advantage when the cornea has by other muscles been at the same time turned outwards. It also tends to draw the cornea inwards as a whole, and to rotate the upper end of its vertical meridian inwards. The inferior rectus, being analogous in position, turns the cornea downwards, acting best while the eye is looking outwards; it also turns the cornea inwards, and rotates the upper half of the cornea outwards. The superior oblique, running as it does backwards and outwards from the pulley, turns the cornea downwards, acting best when the eye is looking inwards; and in addition, it moves the cornea outwards as a whole, while rotating its upper half inwards. The inferior oblique turns the cornea upwards, acting best when the eye is looking inwards; also turning the whole cornea outwards and rotating its upper half outwards. A moment's comparison of these statements, which indicate roughly the actions of the various muscles, will show that any two of these muscles agree in one of the three actions which each accomplishes, while they differ in the other two. For example, the superior rectus and the inferior oblique agree in moving the eye upwards, but the former turns the cornea as a whole, and its upper part, inwards, while the latter has precisely contrary actions. It will further be noted that there exists a difference in regard even to that function which they perform in common; thus, taking the same two muscles, the superior rectus acts best as an elevator when the eye is turned outwards, the inferior oblique when the eye is looking inwards (towards the nose). The importance of this fact will be seen presently.

We are in a position now, having refreshed our memory in regard to the principal function of each muscle, to approach the question of the precise muscle involved in any case of binocular diplopia.

(*a*) It is clear, in the first place, that each muscle having a principal action of its own, and in the case of all but two, also subsidiary actions, it will be in the line of that principal action that the failure will become manifest. Thus if the chief function of a muscle be to move the cornea downwards, double vision will become manifest, or most manifest, when an attempt is made to look downwards; and further, if the function of that muscle is best exercised when the eye is at the same time looking inwards, it will be in that attitude that the double vision will be most obvious of all, the images will there be farther apart. There is no muscle whose function can be taken up and discharged by any other or combination of others; if the external rectus be paralysed, no doubt there are other two muscles (the obliques) which move the cornea outwards, but they are quite incapable of taking up the rôle of the external rectus—and so with all the others. We come to this then, that it is in the direction in which a muscle has normally its maximum efficacy that its failure to act comes to be most evident. It must not, however, be supposed that in no other directions can double vision be demonstrated, but the patient is, generally speaking, not conscious of it; though the fact that the position of the eye is incorrect can, with proper means, be demonstrated also. In paralysis of the external rectus, to return to this as an example, double vision is complained of upon looking outwards; but if we deprive the patient of any power to fuse images which are near together by employing a vertical prism to separate them vertically, lateral separation of the images, due to inefficiency in the active or in the controlling power of the external rectus, becomes evident over the whole field.

The first point in proceeding to the discovery of the actual muscle involved is to ascertain in what chief direction diplopia is complained of. It is a muscle whose duty it is to move the eye in that direction which is paralysed. The patient says he sees double on looking downwards; the immediate and perfectly correct conclusion is that the muscle paralysed is one whose (abrogated) function it is to turn the cornea downwards. And, further, the vertical separation of the two images will be greater either to the left hand or to the right, the eye being at the same time in an attitude of looking down, according as the muscle involved is facilitated in its action under ordinary conditions by the eye being at the same moment turned to left or to right. The first rule, then, is that double vision is to be found in one or other of the great directions, upwards, downwards, to right or to left of the patient, and the muscle paralysed is one of those whose function it is to move the eye in that direction.

(*b*) As one moves the test object, which for convenience sake is often a lighted candle, farther and farther in the direction in which double vision exists (say, downwards), the call upon the enfeebled muscle increasing, and its inability to meet the demand becoming more obvious, the separation of the two images, the false and the true, becomes ever wider and wider; it is easy to decide which image belongs to which eye by means of a coloured glass held before one eye, or by suddenly interposing a screen before one eye, and causing the patient to say which image is coloured or which has disappeared; but that is not enough, we require to know which is the false image,—which, that is, belongs to the misdirected eye. The answer to this question, which is one that gives much trouble to the beginner, is simply that the image which is farthest in the direction in which double vision exists is the false image. If the diplopia is manifest below, the lower image is the false, belonging to the paralysed eye; if the diplopia is greatest to the left hand side, that image most to the left is the false, and so on. This gives the answer to the second question, namely, Which is the affected eye?

(*c*) The third question, Which muscle of that eye is paralysed? is answered by the observation that the false image is deviated exactly in the direction of action of the paralysed muscle. Thus, to take the three directions of error, if the false image is above the true, the muscle paralysed is an elevator (and similarly with the depressors); if the images are crossed it is an inward mover which is paralysed (and similarly with simple or homonymous diplopia); and if the upper end of the false image is rotated to the right, the paralysed muscle has it as one of its functions to rotate the globe about a sagittal axis so that the upper part of the cornea shall be rotated to the right (and similarly with the left rotation).

The writer ventures to think that this method is the simplest and most "physiological" that can well be employed, since it depends entirely upon a knowledge of the normal action of the muscles in health; it is certainly infinitely better than any mnemonics, which are apt to fail precisely when they are required. It may, perhaps, be useful to give an illustration of the application of these rules:—A man complains of diplopia, which, excluding monocular diplopia, may be due to paralysis of any one of twelve muscles, six in each eye. Employing the first rule, we ascertain that it is in looking downwards that double vision is most manifest; this narrows down the possibilities to the four depressors of the two eyes (superior oblique and inferior rectus). By using a red glass or other method we discover that the lower (false) image belongs to the left eye; the second rule has thus limited the possibilities to the two muscles of the left eye. On further investigation we find that the height-difference increases to the patient's right, which makes it clear that the defaulting muscle must be the left superior oblique. Other confirmatory tests may be added, when it will probably be discovered that the upper end of the false image is twisted to the right, and that the lateral separation is homonymous, in accordance with the physiological action of the superior oblique as explained above. In regard to these confirmatory tests it should be stated that they are apt to fail, and should not be too much relied upon. If there happens, in such a case as is suggested above, to have been in health a tendency to (latent) divergence of the optic axes, as is not infrequently the case, then, when there is no possibility of combining the two images on account of the vertical diplopia, the latent divergence is apt to assert itself, with the result that in place of homonymous, we may have crossed, diplopia. One is sometimes put about, too, by the patient mistaking the vertical for the inclined image, and *vice versa;* the effect of this will be, that in place of saying that the lower image inclines to the right, he may state that the upper inclines to the left. Nor is it a wise plan to speak of the two images inclining to or from one another, but rather to right and to left, since in the event of the separation being crossed when it "ought" to be homonymous one is apt to be led into error. There are numberless minor points in regard to diplopia and the paralysis of the individual muscles, some of great interest and considerable importance, but for the discussion of which the reader must be referred to a good text-book. The precise characters of the diplopia produced by paralysis of each of the muscles severally can be readily deduced from a knowledge of the physiological action, as indicated above. Two or more of the muscles may be paralysed at the same time, a condition which is most apt to be observed when either the trunk of the third nerve is affected, or when all the muscles attached to the eye are paralysed together, a condition known as ophthalmoplegia.

When the whole third nerve is paralysed, there is present, of course, inability to employ any of the external ocular muscles with the exception of the external rectus (sixth nerve) and the superior oblique (fourth nerve). There is, therefore, total inability to move the eye either upwards or inwards, and the power to move downwards is extremely limited, since the superior oblique has but little action as a depressor except when the cornea is turned inwards, a position which it is impossible for the eye to assume from the paralysis of all the inward-movers. The eye, therefore, stands almost stationary in a position of divergence, is incapable of upward movement, and on an attempt to look down does little but rotate slightly about its sagittal axis as the superior oblique turns the upper part of the cornea inwards. The paralysis of the levator palpebræ superioris prevents the patient from being much annoyed by diplopia, but if the lid be raised by the hand, it will be found that there is double vision over the whole field of fixation, save, perhaps, at the extreme outer part. The diplopia is crossed, the separation of the images becoming enormous as the test object passes over to the healthy side; in the upper part of the field the false image is above the true, in the lower half it is below the true. In such a case the pupil and ciliary muscle are also paralysed, the effects of which are discussed elsewhere. In certain cases the levator is less seriously affected than the muscles of the globe, and it and the interior muscles seem to have a tendency to recover more quickly than the others. When ophthalmoplegia occurs all the exterior muscles of the eye are paralysed, with or without affection of the interior. The etiological significance of combinations of the various muscles in their paralysis will be discussed later.

In connection with the subject of diplopia one must draw attention to two points of interest, namely, the relative inconvenience to which the patient is subjected by paralysis of the various muscles, and the untaught, one might almost say reflex, means which he adopts to get rid of the annoyance. Since we have less to do with objects above us than with those on or below the level of the eyes, paralysis of any of the upward-movers causes much less annoyance than in the case of the other muscles; paralysis of a pure lateral-mover is, unless very severe in degree, easily combated by alteration of the position of the head, whereas in walking, and still more in descending a staircase, paralysis of one of the downward-movers causes great inconvenience. The means adopted by the patient consist in so placing the head and eyes that the offending muscle is in its position of greatest inutility, and the bad gearing produced by its inaction is therefore at its minimum. Thus when there is double vision to the left the patient turns his head to the left, and at the same time turns both eyes to the right; the offending left-mover is thus thrown out of action, all the objects with which the patient is dealing at the moment are put over to his right side, and double vision reduced to a minimum. Similarly if the diplopia is in the lower half of the field, the patient endeavours to have as many objects above the level of the eyes as possible, and to do without bringing any depressor into play, by keeping the head lowered and turning the eyes upwards. For the correction of the faulty inclination of the false image, the unusual attitude adopted by the head is much less obvious, but alteration of position may be expressed in this way that (as is, indeed, the case with the other movements) the head is turned in the direction in which the defaulting muscle ought to rotate the eye, or—what is the same thing—in the same sense as the inclination of the false image.

3. Faulty Projection.—The third of the chief points in regard to the symptoms produced by paralysis of ocular muscles, namely, faulty projection, need not detain us long. It depends upon the wrong estimate made by the weak muscle of the amount of effect produced upon the position of the eye by the expenditure of nerve-energy supplied to it. This might be expressed in the following manner:—Suppose that in health enough energy were given out under certain circumstances to rotate the eye through an angle of 30°, if the actual power of the muscle is by paresis reduced to one-third, then with the same expenditure of energy the result will be a movement only through 10°. Now it is by the amount of nerve-energy expended in bringing the macula to bear upon an object, and not by the effect produced, that we judge of its position in space; therefore, in paralysis of any muscle we are apt to "refer" an object to a point in space farther in the line of action of that muscle than it in reality is. In a recent case of paralysis of the external rectus, for example, this can be easily demonstrated. Let the patient cover the sound eye, and while he

fixes your uplifted finger with the affected one, let him dart his finger quickly at yours; it will be found that his finger passes yours on the side of the weak muscle, showing that he has been under the impression that your finger was farther in that direction than it really stood. Other methods of demonstrating the same error of judgment will occur to the reader. In point of fact, it is the existence of this faulty projection, as much as the actual diplopia, which causes the inconvenience and discomfort from which the patient suffers; in descending a stair, for example, he has the double difficulty of seeing double and of imagining the step to be where it is not.

ETIOLOGY

A point of great importance to be settled before any operative or other treatment is begun, is whether a convergent squint is due to a paralytic condition, or to refractive anomaly. The following matters should be inquired into:—

Age of Patient.—Convergent concomitant strabismus usually develops before the age of four or five years; paralysis may occur at any age.

Refraction.—Nearly all convergent concomitant squints are associated with hypermetropia.

Onset.—Concomitant squint at its inception is very often erratic, coming and going for some time, it may be seen at times even for months before becoming fixed; paralytic squint is almost always sudden or rapid in its onset.

Diplopia.—In the great majority of cases of concomitant strabismus diplopia is not complained of, and is difficult to elicit, even on careful testing; on the other hand, diplopia is not, as pointed out above, *invariably* present in paralysis, though it is present in the vast majority of cases.

Primary Deviation.—In concomitant squint the fault of position or degree of convergence is the same all over the field of fixation, as its name implies, while in paralytic squint the error in position is greatest in certain positions.

Secondary Deviation.—When the eye which ordinarily fixes the object is hidden behing the hand or other screen, that which usually squints is then obliged to fix, and the original eye deviates; in concomitant strabismus the secondary deviation is not greater than the primary. In paralytic squint, when the paretic eye is fixing, the effort required on the part of the feeble muscle to draw it into line is much greater than in the case of a normal muscle, and the corresponding impulse sent to the associated lateral muscle of the sound eye, therefore produces a more extensive alteration in position; in other words, the secondary deviation is greater than the primary.

Projection.—In paralytic squint the projection by the misdirected eye is erroneous; it is correct in concomitant strabismus.

When we have decided that such and such a muscle is paralysed, we have only taken the first of a series of steps towards the diagnosis, for we must know also the seat of the lesion and its precise nature, before we can be said to have arrived at an understanding of the case. Where then is the lesion situated? There are four situations, damage in which is capable of producing paralysis of ocular muscles. The lesion may be in the orbit, at the base of the brain, nuclear, or in the nerve paths and centres superior to the nuclei. With the last of these classes we have little to deal in the present article further than to say that, since above the nuclei the nerve impulses are to movements of the globe rather to action of individual muscles, and it is in the nuclei that such impulses are transmitted to the individual muscles, a lesion in that region is not attended by an affection of muscles in the sense in which that phrase is employed here.

Certain general principles, in the first place, guide one in the decision as between the other three possible situations; thus a paralysis which picks out one or more muscles out of several which receive their nerve-supply from one nerve, is much more likely to be peripheral (orbital) than basal. A lesion which affects all the muscles supplied by the third nerve is on the contrary more likely to be intracranial than peripheral, while a lesion affecting the two muscles of accommodation could hardly be other than nuclear. In the decision of these points we are further greatly assisted by the presence or absence of such other symptoms as are exemplified by headache, hemiplegia, and paralysis of the facial nerve.

I. The lesions which have a *nuclear* situation present certain interesting features: (*a*) The paralysis may be congenital, as is probably the case with some of the examples of congenital ptosis with which one meets, especially those in which there is at the same time total inability to move the eye upwards. This could certainly not be of basal origin, nor is it at all likely to be of orbital origin, and produced by non-development of the levator palpebræ, the superior rectus, and the inferior oblique, all of which are, in such a case, unresponsive. (*b*) Headache, so frequent a symptom in various forms of brain disease, may be conspicuously absent, though in other cases it is very severe, and it may precede by a considerable time the paralytic symptoms. (*c*) The paralysis is not infrequently isolated, one or more out of the muscles supplied by one nerve being picked out; thus paralysis of the inferior rectus may be nuclear in its origin, all the other muscles under the command of the third nerve escaping. One of the most striking forms of nuclear paralysis is paralysis of the whole third nerve, except the two interior muscles (iris and accommodation). (*d*) The paralysis is not seldom quite transitory, but reappearing in the same or other muscles; with this one is familiar in the cases of locomotor ataxia, the paralysis occurring sometimes in the earlier stages of which disease are most probably of nuclear origin. (*e*) The paralysis sometimes spreads from one muscle to another, it may even cross over to the other side of the body. (*f*) Other complications may be present at the time, or may follow, which have their origin also in those nuclei which are anatomically in more or less close approximation to those first affected. Thus polyuria and somnolence are not infrequently observed. (*g*) Nuclear paralysis may occur at any age. (*h*) Nuclear paralysis may be acute, recovering rapidly, remaining permanently, or death from complications occurring very shortly; or may be of very slow progress indeed, extending over a number of years, with or without remissions. (*i*) Nuclear paralysis has the curious feature, in many cases, of varying considerably from day to day, or even at different parts of the day, and also of being to a considerable extent under the control of the patient. Thus a nuclear ptosis (excluding the congenital nuclear variety) may seem severe in the evening when the patient is fatigued, and quite trifling in the morning when he is fresh; the patient, too, if urged to make an effort to lift the lid, is often quite well able to do so for a minute or so, but the ptosis gradually reappears so soon as the attention is relaxed.

The condition known as ophthalmoplegia, in which all the exterior muscles without the interior, or all the interior without the exterior, or both combined, are paralysed, is generally due to nuclear lesion; this is all the more certain if the condition is bilateral. There is, however, the possibility of such a condition being produced by a tumour or other gross lesion of the orbit; it may also be basal, and possibly may even be fascicular. It is a noteworthy feature of ophthalmoplegia that the accompanying ptosis is often much slighter in degree than the other paralysis. It is stated by some authors that bilateral ophthalmoplegia is always syphilitic in origin, but the present writer does not see his way to accept so sweeping an assertion.

II. The causes of basal paralysis resolve themselves into three, viz., (*a*) Inflammatory affection involving the nerve trunks (meningitis, etc.); (*b*) Pressure, either directly by tumour of various sorts, by vascular distension, or indirectly by pressure from enlargement of the ventricles, or the existence of a pus formation in the cerebral substance; and (*c*) Disease of the nerve trunks themselves. One ought also to add that the nerves may be injured in fracture of the base of the skull.

III. Paralysis which has its origin in the orbit may be due either to pressure of a tumour of any sort in the orbit or adjoining cavities, to periostitis at the apex of the orbit, to mechanical injury to nerve or muscle, to congenital absence (partial or complete) of a muscle, or to those peripheral lesions which are exemplified by the action of rheumatism, syphilis, diphtheria, and "cold."

If now we look at this question of the origin of any paralysis from an entirely different point of view, we can obtain much information from the study of the various combinations of muscles and nerves involved, including in this review the combination of paralysis of certain of the eye muscles with the implication of other sensory and motor nerves. Certain combinations afford fairly precise information of the seat of the lesion, as indeed we have to some extent already seen. The information thus obtained is naturally of great value in cases of brain lesion above the nuclei (fascicular lesions), as assisting materially to localise the lesion with greater precision.

Bilateral paralysis of both third nerves alone may be nuclear, and if so, the interior muscles may escape; it may arise from compression of the nerves at their point of emergence from the pons, it may be due to basal meningitis, or to pressure from distended blood-vessels at the base. Both external recti may be paralysed from pressure on the two sixth nerves as they lie near together at the posterior margin of the pons, by more diffused pressure produced by tumours in the middle fossa, or by increased intra-cranial tension, or from bilateral disease of the nuclei on the floor of the ventricle; for the long exposed course of the nerve along the base of the skull lays it open to involvement in any inflammatory process in the neighbourhood, to pressure from any intra-cranial cause, and to involvement in injuries.

Progressive paralysis of all the muscles of one eye might be orbital, basal, or nuclear: if orbital, one would expect to find some other evidence of local tumour or inflammation; if it were basal or orbital, the optic nerve of the same eye could hardly long escape damage, while a progressive lesion damaging thus the nuclei might readily spread laterally, and, catching the fibres from the optic tract of the same side, produce hemianopsia, and might even cause hemianæsthesia; a nuclear lesion might also cross to the nuclei of the opposite third nerve. It has been shown that hemiplegia has a curious relation with paralysis of the third nerve of the opposite side:—If the two conditions arise simultaneously, the probable cause is a pontine lesion; if the third nerve paralysis precedes that of the limbs a nuclear lesion in the floor of the ventricle is the cause, while if the limbs are paralysed before the eye, a basal lesion has injured the peduncle and extended its influence to the trunk of the third nerve.

There is probably a cortical centre for elevation of the (opposite) upper lid, situated close to the arm centre, a lesion of which, or of the fibres from it, will cause unilateral ptosis.

Conjugate deviation is that condition in which the eyes are turned to one side, and are incapable of being directed to the other. This is a pretty frequent accompaniment of hemiplegia, and may be either temporary or constant—most usually the former; it may be caused either by paralysis of the muscles moving the eye to one side, or by irritation of the centres (or paths) for movement in the opposite. If the lesion causing this condition be in the hemispheres and of a paralytic character, then the patient "looks away from" his paralysed side; if of an irritative nature, he looks towards his convulsed side, while if the lesion be pontine, the precise contrary is the case, since a lesion in (say) the right side of the pons may catch the tracts going to the left limbs, and at the same time the fibres running from the right sixth nucleus to the right external and left internal recti. Movements of both eyes to one side are initiated (under the volitional centres) from the sixth nucleus of the side towards which the movement is made, and apparently the sixth nucleus has a predominating influence over that portion of the opposite third nerve nucleus which innervates the internal rectus. This only holds good so far as lateral movements are concerned, for it must be kept clearly in mind that paralysis of movement to the right may be present, and on an attempt to move the left eye to the right side the left internal rectus fails to execute the slightest contraction, and yet the patient may exhibit no failure when asked to converge; that is, the left internal rectus will contract readily along with the opposite internal rectus in a movement of convergence, and yet remain quite inactive on an attempt to look to the right side. An apparent conjugate deviation is sometimes to be noticed in hemianopsia, the patient having lost the visual stimulus to movements towards the blind side. A lesion in the pons does not necessarily affect the other internal rectus, however, it may cause paralysis of the sixth nerve alone. In lesions of the sixth nucleus the facial nerve is apt also to suffer, the two nuclei being in very close apposition.

Along with the affections of the muscles must be reckoned one or two conditions very much less frequent than the paralysis of which we have been speaking. Of these the first is paralysis of convergence. Just as the internal rectus may be paralysed *quoad* conjugate lateral movements, and remain intact *quoad* convergence, as we have seen, so the two internal recti may be incapable of acting together in convergence, though acting freely along with the external rectus in lateral movements. This rare condition, which must have a nuclear origin, occurs under similar conditions to other nuclear lesions; it must on no account be confused with that inability to converge satisfactorily which one sees especially in high myopia, and which is known as insufficiency of convergence, and sometimes, but very incorrectly, as insufficiency of the internal recti. The second condition is the precisely opposite condition, which has been variously regarded as a paralysis of divergence and as a spasm of convergence. This is not the place to discuss an abstruse and controversial question, and it will be sufficient to say that perhaps until we have certain evidence of the normal existence of any function of divergence under ordinary conditions it is safer to regard the lesion as a spasm of convergence, for as regards the existence of a function of convergence there can be no doubt. The condition is extremely rare. Paralysis of upward or of downward movement of the eyes is also met with; the former is not infrequently associated with congenital ptosis, and may be either unilateral or bilateral: its origin is probably either nuclear or superior to the nuclei.

Along with some other symptoms of paralysis of the sympathetic, such as contracted pupil and retraction of the globe, a form of ptosis is sometimes met with. A peculiar affection of the third nerve, to which, when accompanied by hemicrania on the same side, Charcot gave the name of ophthalmic migraine, is occasionally seen, in which paralysis, usually if not always attacking the whole nerve, comes on, is recovered from, and recurs again and again; this is sometimes associated with the menstrual function in women, but it occurs also in men. It is still a question which awaits decision whether such cases are nuclear or basal in their origin; certainly in some there has been disease of the trunk of the nerve. Another peculiar condition is congenital paralysis of one or both of the sixth nerves; in this condition there are two puzzling circumstances, namely, that secondary deviation may be entirely absent, and that, as a rule, on cessation of attempted movement to one or other side, the eyes are brought spontaneously to mid position again.

As regards the etiology of ocular paralysis one need not be other than brief. Syphilis accounts for a very large proportion of the cases either directly or indirectly; for apart from those cases, not indeed very numerous, in which various muscles may be paralysed as a "direct" manifestation of syphilis, one must consider those occurring from the pressure of a gumma, or the result of syphilitic disease of vessels, and those which form, sometimes early, sometimes later, manifestations of locomotor ataxy—itself so frequently of syphilitic origin. Tubercular lesions account for a considerable number of the remainder, both by pressure of nodules, by meningitis, and direct disease of nuclei. Diabetes and diphtheria are alike in this respect, that the toxin of each is able to cause nuclear paralysis (*e.g.* of accommodation), and in the course of either inflammatory complications are apt to lead to direct paralysis of peripheral nerves. A certain proportion of cases is due to trauma, either intra-cranial, as when the sixth nerves are implicated in a fracture of the base of the skull, or orbital, as when the inferior oblique is injured by a blow or penetrating wound damaging the floor of the orbit. (It is said that the inferior oblique is never paralysed alone except by trauma.) But a large number of cases have to be attributed to rheumatism and to "cold"; these causes are specially prone to affect the external rectus muscle, and are not infrequently recurrent. Indirectly, also, Bright's disease is responsible for certain cases.

On the question of *prognosis* a few words must be said, and it is convenient to take the different situations of the lesions separately. Fascicular lesions depend entirely for their prognosis on the nature and situation of the damage, and on its completeness. The articles upon various cerebral lesions should be consulted. Nuclear lesions vary very greatly in this matter, for while some are excessively slowly progressive (cases have been known to become very gradually worse during a period of twenty years), others pass away in a few days, while yet others are followed speedily by death. As a general rule, if the onset be sudden, the patient will either recover or the condition will remain stationary; it is rare for a sudden onset to be followed by slow progress. Thus the prognosis in post-diphtheritic paralysis of accommodation, which is an acutely occurring nuclear paralysis, is very good; that of the ophthalmoplegia of children is fairly good, for most of the patients recover completely, although in a few the result is very different. In the author's experience, again, nuclear paralyses occurring in diabetes have been of very sinister import, though all writers do not consider them so very grave. In the paralyses of locomotor ataxy, as we have seen, which are probably nuclear in situation, the prospect of recovery is good, but in this as in some other conditions there is danger of recurrence. In such basal paralyses as are occasioned by pressure of a neoplasm upon the nerve, or by its implication in an actual fracture, no improvement is of course to be looked for, and in those cases in which a meningitis has been the cause, the nerves becoming either implicated in the inflammation or pressed on by the effusion, the chief consideration is the continued life of the patient; but this granted, and the health of the patient improved, a wonderful degree of improvement in the muscular condition may also occur. In the orbital causes of paralysis, as well as in the two last headings, a very great deal depends upon the question whether the lesion is or is not syphilitic; if it be, the prognosis is good, and even after a long time of apparent unsuccess one may see a paralysis pass quickly away, whether produced by a nuclear lesion, the pressure of a gumma at the base, or an orbital affection. In the ordinary orbital paralysis recovery is the rule, but not without exception, though the process is sometimes distressingly slow.

The *treatment* of paralysis of any of the ocular muscles, must, in the first instance, proceed upon the lines which are indicated by its etiology: in a rheumatic patient we should employ anti-rheumatic remedies internally; in a syphilitic, anti-syphilitics, and so on. Locally the only treatment which is, in the opinion of the writer, likely to be of much service is blistering, and its period of probable benefit is but short. The method which he prefers is to apply the blister over a very small area of the temple, and to repeat it over a neighbouring portion of skin two or three times at intervals of forty-eight hours. Blistering has fallen apparently into disrepute, not because it is ineffective, for in truth it is of great service, but chiefly, as it seems to the writer, because pathologists find a little difficulty in explaining the mode in which it acts; it has the misfortune to be, or to look as if it were, at variance with accepted theories, and therefore practitioners are apt to look askance at it. On the other hand, the author cannot recommend the application of electricity to the paralysed muscle, a method of treatment in which some place reliance. Michel recommended mechanical traction of the globe in the line of action of the muscle involved; he administered cocaine, and then (supposing the external rectus to be the muscle involved) seized the conjunctiva with fixation forceps, and gently pulled the cornea outwards and inwards alternately with the idea of assisting the muscle to recover tone. The author is not aware whether the method is still employed by any surgeon now.

In post-diphtheritic paralysis of accommodation simple tonics should be given, and with time the power of the ciliary muscle will recover. It generally does so very rapidly after the lapse of a few weeks of almost complete paralysis; the author sees no advantage in the employment of eserine, which is sometimes recommended. Since the lesion is not muscular, but nuclear, such "treatment" is not in the true sense treatment at all. As well might one turn the hands of the clock round the dial with one's finger when the works are damaged. Nor can we see what possible advantage is gained by ordering convex spectacles, save as a very temporary relief to symptoms.

Manifestly in cases in which the nerve is destroyed by tumour pressure or by tearing across, no medicine can restore its function.

In such cases as resist all treatment and remain permanent it may, however, be necessary to resort to remedies of a character totally different from any which we have yet mentioned.

In the case of a patient suffering from an incurable paralysis of an ocular muscle, and continuing to be seriously annoyed by double vision from this cause, we may have recourse to the use of a prism held before the eye or eyes in such a position as to neutralise the faulty attitude of the visual lines. To take one of the simplest cases, in permanent partial paralysis, or during the slow course of recovery from a paralysis of the external rectus muscle of the right eye, there may be troublesome diplopia in all positions save when the patient is looking towards his left side; such a person may have his discomfort much relieved by the wearing of a prism before the right eye with its apex inwards, which will thus neutralise the effect of his too great convergence. In certain cases, especially when the patient does not require any convex or concave glasses, it would be highly inconvenient to wear a single prism, and it is better to divide the effect between the two eyes. Thus, in a case in which a prism of 8° is required, apex upwards, to unite the images, it is better that the patient should wear before each eye a prism of 4°, on one side apex upwards, on the other apex downwards. But even comparatively feeble prisms are so heavy and inconvenient to wear, that in practice it is not very often that they are prescribed. When they are employed care must be taken that they do not quite fully correct the defect, as it is good practice to encourage the enfeebled muscle to efforts at recovery by leaving still a slight separation of the images, which may be overcome when the desire for fusion urges the weak muscle to contract. If full correction is worn there is no incentive to the muscle to act.

Operative measures, which ought never to be undertaken till all hope of recovery has had to be given up, and till perhaps a year or more has elapsed without recovery, may be of several kinds. We may either endeavour to assist an enfeebled muscle to perform its function satisfactorily by bringing its points of origin and insertion nearer together (advancement), or by weakening its antagonist of the same eye, or we may bring the sound eye into line with the affected one by attacking one or more of the muscles of the former either by advancement or tenotomy. To take an example:—in permanent paralysis of the left superior oblique, the eye is in a position of threefold error, viz. it stands too high, it is convergent, and the upper portion of its cornea is rotated outwards, since all three of the contrary actions of the muscle are more or less completely lost. To remedy this condition, then, we may (1) strengthen the weakened muscle (advancement of left superior oblique), or its principal coadjutor (advancement of left inferior rectus), but to do this latter would increase the faulty rotation about the antero-posterior axis; or (2) weaken one or both of the antagonists of the same eye (tenotomy of left superior rectus or left inferior oblique). The former operation would also have the inconvenience of increasing still further the faulty rotation of the eye about the antero-posterior axis, while the latter, even if practicable, would increase the convergence. Or we may displace the other eye in a parallel direction either by (3) weakening the chief muscle which draws it in the parallel direction to that of the paralysed muscle (tenotomy of right inferior rectus), or by (4) strengthening that muscle which draws the right eye in a direction parallel to the actual displacement (advancement of the right superior rectus). It will be seen that tenotomy of the right inferior rectus in all three directions of movement "tunes" the right eye to the new faulty position of the left, while advancement of the superior rectus would be apt to give an increase in convergence, already too great. It need, perhaps, hardly be observed that no operation on the oblique muscles is, as a matter of fact, practicable, although, for the sake of stating the problem completely, interference with them has been suggested in the above scheme, which, *mutatis mutandis,* can be applied to the case of any of the muscles. For a description of the actual methods of operation upon the muscles, whether by tenotomy or by advancement, one of the ordinary text-books had better been consulted.

LITERATURE.—Graefe-Saemisch. *Handbuch der gesamten Augenheilkunde.*—De Wecker and Landolt. *Traité complet d'ophtalmologie.*—Mauthner. *Die Lehre von den Augenmuskellähmungen.*—Maddox. *The Ocular Muscles.*—Various text-books on Ophthalmology, especially Swanzy.

Œdema. *See* Dropsy, Lymphatic System.

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Injuries and Diseases of the Œsophagus.

Anatomical Considerations.—The œsophagus extends from the body of the sixth cervical vertebra, or the disc between the sixth and seventh, to the tenth or eleventh dorsal vertebra. The cricoid cartilage forms the landmark for the commencement of the tube. For practical purposes it is essential to know the distance of certain parts of the œsophagus from the incisor teeth, because it is by means of bougies passed through the mouth that the presence of obstruction is usually ascertained. From the incisor teeth to the commencement of the œsophagus the distance is from 5 to 6 inches. The œsophagus itself is from 9 to 10 inches long, and may be divided into three portions.

(*a*) The cervical portion, extending from the level of the cricoid cartilage to the upper border of the manubrium sterni, measuring 1½ to 2 inches.

(*b*) The thoracic portion, terminating at the aperture in the diaphragm, and measuring 7 inches.

(*c*) The abdominal portion, measuring about 1 inch; thus, if the bougie stops at a distance of 6 to 8 inches from the teeth the obstruction is at the commencement of the œsophagus, and if it stops at 14 to 15 inches the obstruction is at the cardiac end.

The *direction* of the œsophagus in the antero-posterior plane does not follow the line of the vertebral column in its whole extent. As far as the third dorsal vertebra it follows the course of the spinal column, but at this spot it passes almost vertically downwards to the diaphragm. In the frontal plane the œsophagus inclines slightly towards the left side at the junction of its cervical and thoracic portions, and regains the middle line about the fifth dorsal vertebra. It then deviates again slightly to the left as it passes through the diaphragm.

It is most important to know accurately the relations of the œsophagus. In the *neck* the right recurrent laryngeal nerve lies along its right side, whereas the left nerve lies just at its anterior surface; hence, when the œsophagus is exposed on the left side (the usual side for the operation of œsophagotomy), it is important to avoid the nerve by opening the œsophagus rather on its posterior than its anterior surface. The inferior thyroid veins form a plexus on the anterior surface of the tube, and the left inferior thyroid artery lies in contact with its left side.

In the thorax at the bifurcation of the trachea the œsophagus is rather to the left of the middle line, so that the left bronchus lies against its anterior surface—a fact which accounts for the greater frequency with which the left bronchus is implicated in growths of the œsophagus. In the angle between the two bronchi are several lymphatic glands, and these, when the seat of abscesses, may discharge their contents into the bronchi; further, in cases where cicatricial tissue forms in and around these glands, the lumen of the bronchi may be somewhat narrowed by the contracting tissue. Below the bifurcation of the trachea the pericardium lies immediately in front of the œsophagus, and on rare occasions a bougie has been passed through an ulcerating growth into the pericardium, and the sword-swallower has wounded his heart owing to this proximity. The relation of the pleuræ to the œsophagus has some practical importance. Below the level of the eighth dorsal vertebra the right pleura passes towards the back of the œsophagus lying between it and the vertical column; on the left side the pleura is in contact with the front of the œsophagus only. This closer relationship of the œsophagus and the right pleura is shown by the fact that growths of the œsophagus more often invade the right than the left pleura. From a surgical point of view it is important to remember this fact, as, in approaching the œsophagus from behind in the thorax, it should never be done on the right side below the eighth dorsal vertebra. Above the eighth dorsal vertebra it is safer to expose the œsophagus on the right side, as the aorta is at some distance away to the left. It would be impossible to remove any part of the œsophagus below the diaphragm without removing the vagi. In animals section of the nerves at this level does not seem to be a serious matter.

Examination of the Œsophagus.—In the neck it is sometimes possible to feel a distended diverticulum or a foreign body. Very rarely, indeed, can a growth of the œsophagus be felt in the neck. In the thorax and abdomen palpation is, of course, out of the question. Of all the methods for detecting obstruction in the œsophagus the gum elastic bougie is the most useful. It should be softened just before use by being held for a minute or two in hot water, and then lubricated with a little glycerine. Provided no violence is employed this method is a safe one. It is, however, possible that even with a slight amount of force the œsophagus might be perforated in the region of a very advanced growth, or that an aneurysm of the aorta, which had nearly destroyed the wall of the œsophagus at one point, might be entered by quite gentle pressure. Such cases, however, are extremely rare, and the inevitable fatal termination is only anticipated by a short time.

Examination of the œsophagus by a lamp or mirror, or *Œsophagoscopy* as it is sometimes called, has been found of some use, but it requires considerable experience, and seldom leads to any more definite information than the ordinary methods afford.

Auscultation of the œsophagus has been found useful by some practitioners. The patient is told to swallow liquids, and the stethoscope is placed at various points along the vertebral column in order to appreciate any abnormal sounds produced by the presence of a stricture.

Radiography has proved of the greatest service in localising the position of foreign bodies in the œsophagus.

In examining the œsophagus it is important to bear in mind that there are three spots where the œsophagus is decidely narrower than the rest of the tube—namely, at the commencement, at a spot adjacent to the bifurcation of the trachea, and its termination. At these points the diameter is about five-eighths of an inch, so that no bougie of greater diameter than half an inch should be used.

When the œsophagus is exposed at the root of the neck it has a certain amount of mobility in two planes. There is a certain amount of side to side movement and there is a slight mobility in its own axis, so that the lower part of the œsophagus can be pulled upwards for about an inch.

Wounds and Rupture of the Œsophagus.—Wounds of the œsophagus alone, apart from injuries of neighbouring structures, are very seldom met with in suicidal wounds. In sabre cuts of the neck and in gunshot wounds the injury to the œsophagus is of small moment compared with that of the trachea, great vessels, etc. As a rule it is only in very extensive wounds, indeed, that the œsophagus is wounded, and the patient generally dies from hæmorrhage or asphyxia before the wounded œsophagus can give rise to any symptoms. Occasionally the œsophagus has been wounded by the introduction of large foreign bodies, such as are used by sword swallowers. If the œsophagus alone is wounded, without any external wound, there may be no symptom until cellulitis appears at the root of the neck or surgical empyema, or some septic complication of the lungs or pleuræ. When there is an external wound in the neck the escape of saliva and food establishes the diagnosis.

The *treatment* depends upon whether the wound is complete or incomplete. If incomplete the œsophagus must be well exposed and, if possible, sutured. An œsophageal catheter is then passed through the mouth and left in position for a week or ten days. The external wound is carefully plugged with gauze, and every care is taken that if leakage occurs the discharges can drain freely away.

If *complete*, every effort should be made to stitch the ends together, or, at any rate, to bring them together as much as possible. A catheter is then left in, and the resulting fibrous stricture must be dealt with later.

Rupture of the œsophagus is a rare accident. Spontaneous rupture has occurred in a practically healthy tube, but more frequently the wall of the œsophagus has been weakened by ulceration or malignant growths.

Inflammation of the Œsophagus.—Acute inflammation of the œsophagus has been met with as a complication in some of the acute specific fevers, such as typhoid and scarlet fever. It has also been described in cholera. Morrell Mackenzie described an *acute idiopathic œsophagitis*, but nothing very definite as regards its etiology could be stated. Such cases are very rare. In children there is a form of acute œsophagitis said to be due to bad feeding, and a condition associated with thrush is occasionally met with termed *aphthous œsophagitis*. In diphtheria the inflammation may extend from the pharynx, and the membrane may form in the œsophagus. As a rule this fact is only ascertained at the post-mortem.

Of more common occurrence is *acute traumatic œsophagitis*. This may be caused by the passage of irregular shaped foreign bodies, but in these cases it is not, as a rule, at all serious, soon subsiding. Much more important is the acute inflammation following the swallowing of corrosive and caustic liquids such as sulphuric, nitric, hydrochloric, acetic, and oxalic acids, and caustic potash, soda, and ammonia. The degree of inflammation varies according to the amount and degree of dilution of the fluid. These liquids produce a slough of greater or less extent and of a different colour, according to the liquid swallowed, thus:—

Sulphuric acid	Brown
Nitric acid	Yellow or orange
Hydrochloric acid	Gray or leaden colour
Oxalic acid	White or cream colour

Around the tissue that is immediately killed by the acid inflammatory changes soon occur, and on the separation of the sloughs there may be hæmorrhage or perforation. If the patient recovers from these dangers there will always be fibrous stricture.

Symptoms.—Intense pain accompanied by symptoms of shock are the two prominent symptoms. If the patient survives the shock there may be a period of freedom from pain and absence of any definite symptoms. Within twenty-four hours or earlier colicky pains in the abdomen, diarrhœa, with bloody stools, and symptoms pointing generally to implication of the abdominal viscera, appear. So far as the œsophagus is concerned there may be cellulitis spreading in the mediastinum, and fistulæ forming in connection with the trachea and bronchi. If the patient escapes all these dangers there are yet the symptoms associated with fibrous stricture to develop.

Treatment.—Immediate neutralisation of the poison by an appropriate draught, and the washing out of the stomach by a syphon, or, if that is not obtainable, by induced vomiting. Abundance of white of egg and water should be given to drink. The patient should be fed solely on milk. If there is dysphagia the patient must be fed per rectum. For the symptoms and treatment of fibrous stricture see page 496.

Foreign Bodies.—A great variety of foreign bodies have been swallowed and detained in the œsophagus. In the case of ordinary adult persons artificial teeth and coins are the most common objects. With children a much greater diversity of bodies are swallowed, and with lunatics a most extraordinary variety of foreign bodies have been found—forks, spoons, penknives, etc.

Symptoms.—These vary enormously according to the size and shape of the body, and they fall naturally into two groups. The immediate or primary, and the secondary or remote symptoms.

Immediate or Primary Symptoms.—When the body is a large one there is a sense of stifling or suffocation, with an extreme anxiety or even a feeling of impending death, which may be due to actual pressure on the respiratory tract, or to some reflex nervous affection; sometimes to a combination of the two. The voice becomes altered, and the act of swallowing is inhibited, and there is often vomiting and coughing. Pain is generally a marked symptom. It is shooting in character, radiating up and down the neck; it may be in the sternal region or in the back between the scapulæ, the exact distribution of the pain depending upon the part of the œsophagus in which the body lodges. After a few minutes these acute symptoms usually subside, leaving a persistent pain, increased by swallowing or vomiting, and generally some alteration of the voice. There is difficulty in deglutition, and sometimes a swelling can be felt in the neck. The duration and severity of these symptoms naturally depend upon the size and shape of the foreign body, and consequently there is a very wide range in the clinical features of these cases.

Remote or Secondary Symptoms.—The most important of these is hæmorrhage, as the result of ulceration of the wall of the œsophagus into the wall of one of the great vessels—the aorta, carotids, pulmonary artery, and venæ cavæ. This even may occur as early as the seventh or eighth day, or at the end of six months. There may be one huge gush of blood or frequent hæmorrhages of varying extent. The ulceration of the œsophagus may involve the trachea, bronchi, or pleuræ, leading to various septic troubles, empyema, septic pneumonia, etc. Septic inflammation may spread to all the tissues in the neighbourhood, leading more especially to cellulitis or abscess in the posterior mediastinum.

Diagnosis.—Just at first it may be difficult to say whether the body is in the respiratory tract or in the œsophagus. As soon as the acute symptoms subside this matter can be easily settled by a careful examination of the symptoms and by means of a laryngoscope, etc. The exact position of the foreign body is not always easily determined; the œsophageal bougie or probang may fail to localise it. In practically all cases radiography at once solves the question of localisation.

Treatment.—There are numerous methods employed which may be classified as follows:—

(1) *Propulsion.*—If the body is a piece of food it may with safety be pushed on into the stomach, also if it is a smooth body that is not likely to cause any trouble in its passage along the alimentary canal.

(2) *Removal through the Mouth.*—Induced vomiting has sometimes been successful, but if the body is large and irregular in shape the proceeding may become dangerous. Numerous instruments have been designed for the purpose of removing foreign bodies from the œsophagus: a flexible bougie with a ring at the end, the ordinary coin catcher, the probang, various forms of forceps, and by special means for particular cases.

(3) *Operative Procedure.*—If all simple methods have failed, it is advisable not to delay if the case is a suitable one for operation. Much mischief may ensue while the body remains *in situ*, and there is very little chance of the body being expelled spontaneously. The operative procedures are:—Cervical œsophagotomy, thoracic œsophagotomy, and gastrotomy.

(*a*) *Cervical Œsophagotomy.*—If the foreign body is impacted in the upper half of the œsophagus this operation is most likely to be successful. When the foreign body is in the cervical portion of the œsophagus there is generally little or no difficulty in removing it. When the body is in the thoracic portion this operation enables one to use instruments for its extraction to much greater advantage than through the mouth. The operation consists in making a skin incision from 3 to 4 inches long in the middle line between the larynx and the supra-sternal notch. The anterior border of the left sterno-mastoid muscle is exposed and hooked outwards. The omo-hyoid muscle is divided. The sterno-hyoid and sterno-thyroid muscles are also divided but carefully preserved, so that they can be sutured together again. The trachea, together with the thyroid gland, is gently pulled towards the right. As a rule it is not necessary to retract the carotid artery and jugular vein. As soon as the trachea is pulled to the right the œsophagus is readily found at the level of the cricoid cartilage, deviating to the left of the middle line. With care the tube can be exposed for about two inches. If the foreign body can be felt the tube should be opened at the most convenient spot. If the body is below the level of the wound the œsophagus should be opened as low down as possible, taking care to avoid the left recurrent laryngeal nerve. By means of suitable forceps it may then be possible to extract the foreign body. Unless the œsophagus is much damaged the incision into it should be stitched with catgut and the wound carefully drained.

(*b*) *Thoracic Œsophagotomy.*—If the foreign body is definitely localised in the lower part of the thoracic portion, it has been suggested that the œsophagus should be reached by removing portions of three or four ribs near their angles and taking care to avoid wounding the pleura. Above the level of the eighth dorsal vertebra it would be safer to operate on the right side, so as to avoid the aorta. Below the level of the eighth dorsal the pleura on the right side passes to the back of the œsophagus between it and the vertebral column, so that it would be safer to approach it on the left side. I am not aware that this operation has been successfully performed on the living subject.

(*c*) *Gastrotomy.*—In cases where the foreign body is implicated near the cardiac orifice, it may be necessary to open the stomach and to endeavour to remove the foreign body by that route.

GROWTHS OF THE ŒSOPHAGUS.—*Simple Tumours.*—These are very rarely met with. Whatever their structure may be they have a great tendency to assume a polypoid form, *i.e.*, they have a pedicle of varying length. Most of the recorded cases were fibromata, myomata, myxomata, and curious growths containing cysts filled with altered blood. They are quite surgical curiosities.

Malignant.—These are practically always carcinomata. One or two cases of sarcoma have been described. Carcinoma may occur at any part of the œsophagus, but tends to form at those places where the calibre is the narrowest, namely, at the commencement, about the middle, and at the termination. There is a difference of opinion as to the relative frequency with which these three spots are affected, some considering that the upper end is more commonly affected than the others, and *vice versa.* All agree that the middle region accounts for 25 per cent of the whole. Growths of the œsophagus occur more frequently in men than in women. They are nearly always squamous-celled epitheliomata, but glandular carcinoma, probably originating in the œsophageal glands, are sometimes met with. Extension of the growth may take place by direct continuity; thus the lungs or heart may be invaded, and masses of cancer may form round the œsophagus at any part of its course. Secondary deposits may occur in the liver, kidneys, spleen, intestines, etc. The usual lymphatic glands to be affected are those in the posterior mediastinum and those in the lower part of the neck, either along the carotid artery or in the posterior triangle just above the clavicle. The growth may disintegrate at certain spots, and finally there may be a perforation into the posterior mediastinum leading to secondary septic processes.

Symptoms.—The earliest symptom is some difficulty in swallowing, especially if the food is rather dry. This difficulty soon becomes more marked until only liquids can be passed through. The food remains for a minute or two and is then gulped up. If there is much ulceration, especially when septic inflammation spreads from the growth along the œsophagus, there may be reflex spasmodic contractions of the gullet, which may be set up by the slightest amount of food solid or liquid. In the intervals of feeding, blood, and mucus, and débris may be brought up.

Pain is absent at first even when the dysphagia is quite marked. After a time, however, there is definite pain on swallowing referred to the neck or between the shoulders behind. Sometimes the pain is referred to the middle of the sternum or to the lower end of that bone. The distribution of this referred pain depends upon the situation of the growth in the œsophagus.

Emaciation is a prominent symptom. It is partly due to the ordinary emaciation and cachexia of all cancerous disease, and partly to the deprivation of food. There are various complications that may arise. As in the case of foreign bodies, so here hæmorrhage may occur from ulceration into the big vessels. There is alteration of voice either by invasion of the larynx or trachea, or by involving the recurrent laryngeal nerves.

The pleuræ and lungs may be invaded by the growth, and sometimes the pericardium.

Diagnosis.—As a rule this is fairly easy. Progressive difficulty in swallowing, together with definite loss of flesh and cachexia, form a fairly characteristic picture. Careful examination of the heart and great vessels should be made in order to exclude the presence of an aneurysm of the aorta. From a fibrous stricture the presence of hard enlarged glands in the supra-clavicular fossa and along the carotid artery serves to aid us in the diagnosis.

Treatment.—The first question that naturally arises is whether we can hope for a cure of the condition by removal of the growth. This is only possible, of course, when the whole growth and any infected lymphatic glands can be freely removed. This is only feasible in carcinoma of the cervical portion, and then only when the growth is quite limited and free from adhesions to the larynx, trachea, bronchi, thyroid gland, etc. A few cases of successful removal have been reported, the longest of which survived thirteen months. In this case it was necessary to pass a bougie at frequent intervals in order to keep the resulting fibrous stricture sufficiently dilated, and all of them had to be fed on liquid food for the remainder of their lives. It is obvious that cases suitable for radical operative treatment are very rarely met with.

Palliative Treatment.—Short of removal of the growth there are two methods of treatment.

(1) To feed the patient by the mouth with the aid of some apparatus.

(2) To establish an artificial mouth.

(1) Suggestions and attempts at feeding the patient by introducing a tube through the growth and leaving it *in situ* have been published for many years, but this method of treatment was first thoroughly formulated by Symonds. It may be termed permanent intubation of the œsophagus. The principle is to pass a tube through the obstructions, a tube of sufficient length to project well beyond the lower limit of the growth. It has a funnel-shaped opening at the upper end which rests upon the superior margin of the constriction. Symonds describes the procedure in the following words:—

"First ascertain by a large bougie the exact position of the stricture, *i.e.* the number of inches from the teeth; then pass the largest conical bougie possible, and judge by this the size of the tube to be used. Fitting now the introducer (made of whalebone and enclosed by a gum elastic sheath) mark on it the distance on the stricture, or make a knot in the silk (the cords which are attached to the upper dilated part of the tube), and insert with the head thrown back. When it has entered the stricture send the tube down slowly, till arrested by the funnel, and withdraw the introducer. . . . The silk is now tied round the ear and fixed behind by a piece of strapping."

In some cases a long tube is better than a short one, *e.g.* in cases where ulceration has taken place into the pleural cavity, lungs, bronchi, or trachea, and in cases where much destruction of the œsophagus is going on as shown by fœtor. In cases where the disease is situated so high up that the funnel-shaped end of the short tube would rest against the upper aperture of the larynx, and so interfere with respiration, a long tube brought out of the mouth or through the nostrils is indicated. A long tube may be purchased, made in the same way as an ordinary short tube, or according to Symonds it may be quickly improvised in the following manner:—Take a piece of red rubber drainage tube with a thin wall and a wide bore and about eighteen inches long. Cut one end obliquely and sew it up, thus obtaining a conical end; next cut a large eye in the tube about an inch from the extremity, or two openings may be made.. Oil the interior of the tube and introducer thoroughly.

The experience of surgeons concerning œsophageal intubation is rather conflicting. The author is of opinion that it is the best treatment, and should always be tried in cases where the tube can be used of sufficient calibre to avoid repeated blockage of its lumen; in other words, the malignant stricture must not have advanced too far, and the presence of the tube must not induce hæmorrhage and copious mucous discharges from the growth.

(2) Methods to create an artificial mouth.

Œsophagostomy has a very limited field. It is only possible in growths high up and very limited in extent, so that a portion of healthy œsophagus can be found at the root of the neck quite free from growth. Such cases are rare.

Gastrostomy.—Much discussion has taken place concerning the question of early or late gastrostomy. The author is strongly of opinion that so long as the patient can get enough liquid food into the stomach no operation should be performed. As an operation of expediency gastrostomy is not to be recommended. It should be reserved as an operation of necessity, *i.e.* to prevent starvation.

Fibrous Stricture of the Œsophagus.—The most common cause is the swallowing of caustic fluids and boiling water. It seems certain that syphilitic ulceration may lead to stricture. In some cases it is impossible to determine the cause.

Symptoms.—In most cases there have been acute symptoms due to the agent inflicting the damage, and these have already been dealt with in the section on inflammation of the œsophagus. The chief symptom due to the fibrous stricture alone is progressive difficulty in swallowing; pain is seldom present, and, if complained of, it is usually when attempts are made to swallow solid food.

Diagnosis is made by the history of the case. Its site, or at any rate the position of the first stricture, if there be more than one, is usually ascertained by the bougie. In those rare cases where there is no clue to the causation it may be difficult to diagnose the condition from carcinoma or from muscular spasm. By a careful consideration of the symptoms, however, a correct diagnosis can nearly always be made.

Prognosis.—Even with constant treatment the outlook is grave. The fatal end arrives sooner or later by suppuration and perforation, even if starvation is prevented. The infection of the constantly irritated tissue with tubercle is not an infrequent complication.

Treatment.—Numerous methods have been described, some of which soon fell into well-merited neglect; cauterisation, internal œsophagotomy, electrolysis, etc., have practically disappeared as recognised procedures.

With all cases one method must be tried, and that is *gradual dilation.*

Bougies, of which a large variety have been invented, are passed at regular intervals, increasing in size on each occasion. If there is some difficulty in introducing the bougie it may be left in for some minutes or hours and then its reintroduction is quite easy. In some cases Symonds' tube worn for a few days causes a dilatation just as a catheter tied in the urethra.

If a bougie cannot be passed from above into the stomach, although the patient can swallow liquids, the operation of gastrostomy is performed, and the patient is made to swallow a shot to which silk is attached. This silk is brought out of the gastric opening and bougies are dragged through by this means. If nothing can be got to pass by swallowing, the operation of œsophagotomy may be performed, and something passed along by that route. The opening in the stomach may be closed as soon as the stricture is made permeable to a bougie. It may be possible to do this at the time when the gastrostomy is performed, so that the wound in the stomach can be sewn up again at the same operation.

Forcible and Rapid Dilatation.—By some surgeons these terms are looked upon as synonymous. Without undue violence, however, it may be possible to rapidly dilate a stricture by passing bougies of increasing size at one sitting. Special instruments have been devised to dilate a stricture forcibly, and even laminaria tents have been employed. These methods are open to several objections, and are not usually practised. If the stricture is near the cardiac end, and no bougie can be passed from above, then the stomach may be opened and the stricture rapidly dilated. Loreta uses an instrument which stretches the stricture to a diameter of two inches. The wound in the stomach is then closed.

Œsophagotomy. — This operation is performed either with a view of dilating a stricture or of establishing an artificial mouth below the level of the stricture.

Gastrostomy.—When every other method has failed this operation must be performed to prevent the patient starving to death. In some cases after the stricture has been given a rest for a few weeks it may be more easily treated.

SPASM OF THE ŒSOPHAGUS: ŒSOPHAGISMUS.—These are cases in which symptoms of obstruction occur without any organic change whatever in the tube, and in which the obstruction is due to a spasmodic contraction of the muscular coat at some part of the tube, generally the upper end. It is possible to get spasm of the œsophagus in the neighbourhood of an ulcer, etc., but this is quite different from the form here described. Œsophagismus is met with generally in women between the ages of eighteen and thirty years, and seems to occur chiefly in persons of a neurotic temperament.

Symptoms.—Very often so-called hysterical symptoms precede an attack. Then quite suddenly there is regurgitation of food, sometimes of liquid as well as solid. This spasm is very often associated with vomiting or coughing. This difficulty may recur several times for several successive days, and sometimes there is an interval of a few days. The symptoms disappear just as suddenly as they appeared. The symptoms may recur after several weeks or months. Pain, as a rule, is absent, although sensations of discomfort are commonly complained of in the region of the neck. The recurrent attacks may last for several years. In a woman seen by the author they had occurred at frequent intervals for twelve years.

Diagnosis.—As a rule this is quite easy. The sudden onset and the sudden disappearance of symptoms are unlike any organic strictures. The age, sex, and temperament of the patient are points highly suggestive of spasmodic stricture.

Exploration with a bougie generally enables us to exclude organic stricture. In another patient of the author's it was, however, necessary to give an anæsthetic before a bougie could be passed, as the spasm was so great that no justifiable force could overcome it.

Treatment.—In nearly all cases the passage of an œsophageal bougie on one or a few occasions is sufficient. If there is a distinctly neurotic temperament the general treatment for that condition should be systematically carried out. In a patient with a fixed idea that there is a mechanical obstruction, the passage of bougies gradually increasing in size will soon dispel it.

Paralysis of the œsophagus is occasionally met with in certain diseases of the central nervous system. In such diseases there is generally a group of symptoms, of which those concerning the œsophagus are only a part, and often quite a subordinate feature in the case. Œsophageal symptoms are usually some difficulty in swallowing, the presence of hiccough, and an irritating cough. For a full description of this trouble see "Bulbar Paralysis," etc.

Dilatation of the Œsophagus and Œsophageal Pouches.—The œsophagus may be uniformly dilated at any part of its course, or it may be dilated at one part of its circumference, so that a pouch or diverticulum is formed. Uniform dilatation of the œsophagus may be congenital or may be due to a fibrous stricture. According to some authors uniform dilatation may be associated with cancer, but this is very seldom met with if at all. It requires a considerable time for an obstruction to cause dilatation of the tube above, and in all probability there is not sufficient time in the case of cancer for this dilatation to develop. In cases where there are several fibrous strictures in the œsophagus there may be a series of dilatations, one above each stricture. Stricture of the cardiac orifice is the one which most often leads to dilatation, but even stenosis of the pylorus has been known to produce it. In the case of these fusiform dilatations the muscular and connective tissue coats are generally hypertrophied, the mucous membrane remaining intact. This fusiform dilatation of the œsophagus presents no points of special interest apart from the fibrous stricture with which it is always associated. There are certain congenital cases which are always associated with congenital stenosis of the cardiac end of the tube. Of greater interest are the *diverticula* or *œsophageal pouches.* These fall into two groups: those formed by traction from without and those formed by pressure from within. The diverticula formed by traction from without are usually small and generally situated near the bifurcation of the trachea, in the region of the lymphatic glands of the mediastinum. They are caused by the formation of cicatricial tissue following inflammatory lesions of the lymphatic glands and pleura. As a rule they consist solely of mucous membrane, and therefore are very liable to be perforated by a foreign body. Owing to their situation they may lead to very grave complications by becoming adherent to such important structures as the aorta, pericardium, bronchi, etc., especially by ulceration occurring into these structures.

The diverticula formed by pressure from within are much more common and of more practical importance. Their ordinary seat is the junction of the pharynx with the œsophagus, and they are generally supposed to have some relation to the branchial clefts. In all probability these diverticula are very minute at first, and increase in size very gradually, so that it may be many years before they are sufficiently large to cause any symptoms. As a rule they have no muscular tissue around them, but simply consist of mucous membrane.

Symptoms.—It is only when the pouch acquires a certain size that it can cause any symptoms, and the first one is usually a slight difficulty in swallowing. This difficulty increases as the meal progresses, and is due to the pressure of the sac and its contents upon the œsophagus. In addition to the pressure exercised by the pouch upon the œsophagus, the larynx may be compressed as well as the trachea and the recurrent laryngeal nerves, so that there may be interference with respiration and with phonation. When the pouch reaches a certain size it may be felt in the neck, and by pressure it may be possible to empty it so that the contents regurgitate into the cavity of the mouth. There is generally a characteristic fœtid odour of the patient's breath, which is due to decomposition taking place in the pouch. On passing an œsophageal bougie it usually enters the pouch, as that seems to be in the direct line of the food. With a few manipulations it may be possible to pass the pouch and enter the main passage of the œsophagus.

Complications are very frequent, especially by the perforation of the pouch into the tissues of the neck or thorax.

Treatment.—The patient should be advised to take small mouthfuls of food, to masticate it well, and to press upon the pouch during the act of swallowing so as to endeavour to prevent the food entering the diverticula. The only satisfactory cure for the trouble is by operation. The pouch should be freely exposed in the neck and removed. The details of the operation would depend upon the situation, size, and relations of the pouch.

MALFORMATIONS OF THE ŒSOPHAGUS.—These are very rare and of no great practical importance. The œsophagus has been found totally absent in a new-born child, and this deficiency is always accompanied by other gross malformations. The œsophagus may be imperfect, an interval of varying extent existing between the two ends, which are usually united with a thread of fibrous tissue. Very often the lower end communicates with the trachea or bronchi. Congenital stenosis of the œsophagus, either at its commencement or at the cardiac end, has been described.

CERTAIN RARE AFFECTIONS OF THE ŒSOPHAGUS.—Tubercle, syphilis, and actinomycosis are occasionally met with in the œsophagus. They present no special features from such diseases occurring in other parts of the body.

A varicose condition of the veins of the œsophagus has been described especially at the upper end of the tube.

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Old Age. *See* SENILITY.

Olfactory Nerve. *See* NOSE.

Onychia. *See* NAILS.

Operations.

The operative measures in use in connection with surgical affections of the different organs and tissues are described under their separate headings (see "Gall Bladder," "Kidney," "Pancreas," etc.). The present section includes "Amputations" and the various operations of obstetric practice.

Amputations

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By amputation we understand the removal, either for injury or disease, of a portion or the whole of a limb.

In performing such an operation the following points must be kept in view:—

(1) To endanger the life of the patient as little as possible.
(2) To minimise the mutilation of the patient's limb.
(3) To obtain a useful stump.

The first and second objects are attained by amputating as far from the trunk as possible.

Regarding the third head more must be said. In amputating through the lower extremity the end to be kept in view is that the stump may be of use for progression afterwards, consequently it must be able to bear the weight of the patient.

The end of the bone must be covered by sound tissue. The cicatrix must be as far as possible out of the way of injury; preferably it should be on the posterior aspect.

No nerves must be involved in the cicatrix, otherwise neuromata may form and give rise to a painful and tender stump.

Amputations through the upper extremity should, if possible, be avoided, as no artificial substitute of a satisfactory nature can replace the upper extremity.

When possible, excision should be performed, but if amputation is found necessary as little as possible should be removed. In the lower extremity length may be sacrificed to get a useful stump, but in the upper extremity an effort must be made to save as much as possible. This is especially important in the hand. The result may not be beautiful, but it is useful, and in this connection I think use is beauty.

Methods Used in Amputating

Circular Method.—In its crudest sense this method consisted in chopping off the limb—skin, muscles, and bone being severed at one level—

followed by the application of pitch, or of the actual cautery, to arrest the hæmorrhage.

This rude method was gradually improved upon, and reached its highest stage of development in the triple incision of Benjamin Bell.

Bell's method consisted in making a circular cut through the skin and subcutaneous tissues. The cuff of skin thus formed was then retracted and the muscles divided at a higher level. Lastly, the muscles were retracted still farther and the bone divided.

By this method an excellent covering for the end of the bone was obtained.

The above method can be most easily carried out where the limb is cylindrical, *e.g.* above the wrist or through the upper arm. Where the limb is conical a modification of the above method must be adopted.

Modified Circular Method.—The body, as a whole, with the exception of a small area above the wrist and the upper arm, may be regarded as composed of cones rather than of cylinders. At the cylindrical portions of the limb Bell's triple incision may be used with advantage, but Syme's modified circular method is preferable in amputating through a conical portion of a limb.

Two skin flaps are made, and after dissecting these flaps up, the muscles are divided circularly at a higher level.

The muscles are retracted and the bone divided at a still higher level.

Flap Method.—Flaps may be made in one of two ways, either by transfixion or by dissection. Transfixion is carried out by passing a long knife through the soft tissues of the limb, and cutting from within outwards.

This is a rapid method, but requires great manual dexterity.

It was much used before the introduction of anæsthetics. Since that date flaps made by dissection have to a large extent replaced the method by transfixion.

As a rule, flaps are cut of unequal length to avoid having the cicatrix opposite the end of the bone.

Racket-shaped or Oval Method.—In carrying out this method the head of the "racket" is formed by making a circular or slightly oblique cut round the limb down to the bone.

The handle of the "racket" is formed by making a vertical cut upwards from the first incision in the long axis of the limb.

The exact position of the vertical cut depends upon the anatomy of the part. Main vessels and subcutaneous bones should be avoided.

This method may be carried out in any situation, the length of the handle of the "racket" depending on the depth of the bone.

The edges of the incisions may be brought together in one of two ways. The immediate result in the one case appearing like an inverted T, which, at a later date, takes the form of a leech bite Y, in the other like the letter L.

AMPUTATIONS THROUGH THE LOWER EXTREMITY

AMPUTATIONS OF THE FOOT.—The usefulness of the foot as a bearing surface depends upon the fact that it is a tripod. In order that the stability of this tripod be not interfered with, it is essential that there be no shortening of any of the limbs, and that there be no approximation of any two of the limbs.

In operations on the foot, therefore, where it is found necessary to interfere with the tripod, sufficient periosteum should, if possible, be left, so that new bone may be formed. By this method shortening of the limbs of the tripod may, to a certain extent, be prevented. This is especially important in operations involving the great and little toes or the os calcis.

To obviate the second difficulty the breadth of the foot, in front, must be preserved. Care should be taken to avoid having the cicatrix on the plantar surface. In all amputations of the foot it is better to dissect the bone off the flap. By thus cutting upon the bone there is less danger of injuring the flap.

Amputation of the Terminal Phalanx of the Great Toe.—In this operation the skin on the under surface of the toe is utilised as a plantar flap. The knife is entered on the dorsum of the toe, opposite the interphalangeal joint; carried through the joint, and then along the under surface of the phalanx. The flap is thus practically cut by transfixion. It can also be made by dissecting it off the bone. The apex of the flap is then stitched to the margin of the incision on the dorsum of the toe, and thus no cicatrix is left on the bearing surface.

The above operation was formerly frequently performed for exostosis. It is now usual simply to remove the tumour with its cartilaginous cap.

Amputation of Second, Third, and Fourth Toes.—Having ascertained the position of the metatarso-phalangeal joint, the surgeon takes a firm grasp of the toe to be amputated, the assistant keeping the other toes out of the way. The knife is entered on the dorsum, immediately above the metatarso-phalangeal joint, and is carried down the toe until the level of the web is reached. At this level the knife is carried circularly round the toe. The result is a racket-shaped incision. The incisions are made down to the bone, and the toe is dissected out, keeping close to the bone. If it is found necessary to remove a portion of the metatarsal bone along with the toe the incision must be begun at a higher level.

Amputation of the Great and Little Toes.—As the above toes are two of the limbs of the tripod it is important to leave them if possible. If either has to be removed an attempt should be made to preserve the head of the corresponding metatarsal bone. The relatively large size of the head of the metatarsal bone should be borne in mind. To get a sufficient covering for this a long flap must be made from the toe to be amputated.

Amputation of all the Toes for Crush.—In such cases each toe must be amputated individually. If sufficient skin cannot be obtained from one toe to cover the head of the corresponding metatarsal bone it must be obtained from a neighbouring toe. Every endeavour must be made to maintain the breadth of the foot.

Tarso-Metatarsal Amputations. — *Hey, Lisfranc.*—There are two methods of amputating at this level. One may either disarticulate the metatarsal from the tarsal bones, or disarticulate the four outer metatarsals, and then saw off the projecting part of the internal cuneiform. The first method is that of Lisfranc, the second is that of Hey. The second operation is only carried out in cases of injury. Disarticulation is preferable in cases of tubercular disease. The flaps are cut in the same way for both operations.

The following landmarks are to be made out: On the outer side of the foot, the projection at the base of the fifth metatarsal bone; on the inner side of the foot, the joint between the internal cuneiform bone and the first metatarsal. This point lies about one inch in front of the tubercle of the scaphoid, which can be easily felt on the inner side of the foot. Beginning at one point the knife is carried along the border of the foot to the base of the toes, from there obliquely across the sole of the foot just behind the webs of the toes, and then along the other border of the foot, thus marking out a long plantar flap. The two points are joined by an incision on the dorsum which is slightly curved forwards. The joints are opened into on the dorsal aspect, and after disarticulation the bones are dissected off the plantar flap.

The great difficulty in disarticulating is the division of the strong ligaments which bind the second metatarsal bone to the cuneiform bones. The best way to divide these ligaments is to put the knife in obliquely at the side of the bone with the cutting edge away from the surgeon. The knife is then to be raised until it is at right angles with the foot, and in this way the ligaments are divided. This must be done on both sides of the metatarsal bone.

Hey's operation, in which the projecting portion of the internal cuneiform is sawn through, is an easier operation to perform.

MID-TARSAL AMPUTATION, CHOPART'S.—Landmarks.—On the outer side, a point midway between the tip of the fifth metatarsal bone and the external malleolus. This corresponds to the joint between the os calcis and the cuboid. On the inner side, the tubercle of the scaphoid. The same incisions are made as in the tarso-metatarsal amputations, but the plantar incision is not carried so far forward. The anterior margin of the plantar flap is oblique, not transverse; the reason being that the tarsus has a greater depth internally than externally. The incision is to be made down to the bone and the bone dissected off the flap. Syme argued that Chopart's amputation was a bad one because of the tilting backwards of the heel which sometimes took place. This evil can be overcome by performing tenotomy of the tendo Achillis should it be found necessary.

AMPUTATIONS AT THE ANKLE JOINT

SYME'S AMPUTATION.—Landmarks.—On the outer side, the tip of the external malleolus. On the inner side, a point corresponding to the tip of the external malleolus, which will be found to be just below the level of the internal malleolus and slightly farther back. The foot being held at a right angle the points are to be joined by incisions across the sole of the foot and across the dorsum. These incisions are made down to the bone. The arteries are divided at this, the first, cut. Syme then dissected the heel flap off the bone; but it is simpler to disarticulate, and dissect the bone off the flap, keeping close to the bone. Care must be taken not to injure the posterior tibial artery as it runs along the back of the astragalus. The lower end of the tibia and fibula are then cleared and sawn off. The whole articular surface must be removed. Any nerves which project may be cut off. It is not advisable to pull upon the tendons and cut them short, as, if this is done, they will retract, leaving a tube of synovial membrane which may give trouble if sepsis occur. An opening for a posterior drain may be made through the skin of the heel, or a drainage tube may be inserted through the outer angle of the wound.

MODIFICATIONS OF SYME'S METHOD.—Mackenzie's Amputation.—In some cases of extensive disease involving the outer ankle no flap can be got from the outer side. In such cases a modification of Syme's amputation is performed in which the flap is taken from the inner side. The knife is entered opposite the tendon of the tibialis anticus, but on a level with the most prominent part of the internal malleolus, carried down the inner side of the foot, then obliquely across the sole, and up along the tendo Achilles to the corresponding point posteriorly. These two points are again joined by an external incision passing over the external malleolus. The bone is now dissected off the flap, and the lower end of the tibia and fibula removed as in Syme's operation. In this operation drainage is more perfect than in Syme's operation.

Pirogoff's Amputation.—The bony points are the same as those for Syme's amputation, but the incision across the sole passes slightly farther forwards. The incisions having been made, the os calcis is exposed and sawn across, part being left in the heel flap. The rest of the foot and the lower end of the tibia and fibula having been taken away the sawn end of the os calcis is brought in contact with the sawn surface of the tibia and fibula. This is an excellent operation in cases of injury as it gives a slightly longer stump than that obtained by Syme's operation. In cases of tubercular disease it is safer to remove the whole of the os calcis.

Amputations through the Lower Third of the Leg

Teale of Leeds laid down the principle of making a long extensor flap. He said the extensor flap should be in length and in breadth equal to half the circumference of the limb. The short flexor flap should be a quarter the length of the extensor flap. The flaps are dissected up and the bone sawn at the level of the base of the flaps. The long anterior flap is then turned to the back of the limb, the resulting cicatrix being T-shaped. This principle is not carried out rigidly; one makes a long extensor flap with rounded ends, and a short flexor flap. I think the important point to attend to is to lift all the soft tissue off the bone and interosseous membrane, and to divide the anterior tibial artery at the apex of the flap. The saw should enter both bones at the same time, so that the last bone to be sawn through will be the tibia.

Amputations below the Knee-Joint

The Upper Third of the Calf (seat of election).—Amputation is often performed in this situation for injury.

Method in which a Posterior Flap is used.—The surgeon places his thumb on the head of the fibula and his forefinger on the inner and posterior border of the tibia, a long knife is then passed in behind the fibula and pushed through to the posterior border of the tibia, and carried downwards behind the bones, making a large flap by transfixion. The knife is now carried across the front of the limb, making an incision curved slightly downwards. There is practically no anterior flap. The tissues are retracted, the bones cleared, and both sawn at once. There may be too much muscle in the posterior flap, and it may be necessary to cut some of the muscle away. The anterior tibial artery may be the cause of another difficulty in this operation, as in some cases it retracts through the interosseous membrane, and is secured with difficulty. The objection to this operation is the weight of the posterior flap. It drags on the line of incision and therefore must be supported. This can best be done by means of a lead splint, which can easily be made from an oblong strip of sheet lead by dividing one end into three, turning up the middle third, and folding over the two sides, thus making a box in which the stump rests.

Modified Circular Method.—Sometimes the above method is not available. In such cases one may use the *modified circular method,* or even the *racket incision.*

In all amputations at this level I recommend the removal of a large slice of the projecting angle of the tibia, so that there will be no tendency to ulceration of the anterior flap.

The head of the fibula, if hanging loose, should not be removed for two reasons: (1) because it gives attachment to the biceps muscle; (2) because the superior tibio-fibular joint communicates with the knee-joint in a certain proportion of cases. Should sepsis occur this might lead to serious and even dangerous complications.

AMPUTATIONS AT THE KNEE-JOINT

By a Long Anterior Flap.—In this amputation, sometimes adopted in cases of injury, the patella is left and the femur is not divided. A very long anterior flap is necessary in order to cover the condyles. If the tissues at the back of the limb are not severely damaged it may be as well to perform amputation at the seat of election. Introduce the knife a little below and behind one condyle of the femur, and carry it down the front of the limb to a point at least two fingers' breadth below the tubercle of the tibia, and then carry it up to the other condyle. Dissect up the skin to the ligamentum patellæ, divide the ligament, and turn up the patella. Make the posterior flap as long as possible, then disarticulate. The cicatrix will be on the posterior aspect and the stump an excellent one. If a sufficiently long flap cannot be obtained portions of the condyles of the femur must be removed.

Stephen Smith's Method.—This is a method sometimes used for disarticulating at the knee-joint by means of lateral flaps. An incision is made, beginning at the tubercle of the tibia in front, curving downwards and outwards to a corresponding point on the posterior aspect of the limb. A similar flap is made on the inner side. The cicatrix in this case is also posterior.

AMPUTATIONS THROUGH THE CONDYLES OF THE FEMUR

Carden's Amputation.—Place the finger and thumb upon the condyles of the femur, then enter the knife behind and on a lower level than the condyle on one side. Carry it in a curved direction over the front of the limb to a corresponding point on the other side. Dissect up the skin flap to the centre of the patella. The assistant then flexes the knee. This carries the patella forward and the joint is entered above the patella. Having opened the joint, make a vertical incision in the long axis of the limb on each side, passing downwards from the upper ends of the anterior curved incision. Then, with one sweep of the knife, make the posterior flap. The bone is sawn just below the level of the highest part of the articular surface. This gives a broad surface and an excellent stump.

Gritti-Stokes' Amputation. — The same incisions are made in the soft parts, but the patella is dissected up with the anterior flap. The bone is not divided as low down as in Carden's operation, but is sawn a little above the articular surface. The patella is left after having its articular surface removed in the following manner:—The anterior flap is grasped so as to expose the articular surface of the bone, and then a thin section of the bone is sawn off. The patella becomes united to the sawn surface of the femur. One advantage of this operation is that the patellar bursa is not interfered with. If the femur is divided too low down there is apt to be tilting of the patella, and I have sometimes found it advantageous in cases of very muscular men to divide the tissues above the patella on the inner surface of the flap. In other cases I have found it an advantage to fix the patella. The cicatrix in this operation has a tendency to pass backwards and upwards.

AMPUTATIONS THROUGH THE THIGH

In amputations through the lower third of the thigh either the operation by long anterior and short posterior flaps or the modified circular method may be employed. In the flap amputation the flaps are made practically as in Carden's operation, but higher up. In amputations through the middle third of the thigh the modified circular method is probably the best. It gives an excellent covering for the femur. In this situation the length of the stump is specially important.

AMPUTATIONS AT THE HIP-JOINT

This operation is comparatively easy after excision of the head of the femur; it is more difficult when performed for injury. Many methods have been proposed for preventing hæmorrhage, one of the great dangers of the operation. Among these may be mentioned gripping of the flap by an assistant; Lister's abdominal tourniquet; Esmarch's plan of applying an elastic bandage round the abdomen with a large pad in front; manual compression of the abdominal aorta. Davy introduced a lever into the rectum to exert pressure on the common iliac artery. Abdominal pressure may be satisfactory, but efficient femoral pressure, where it can be carried out, is preferable. If the thigh is large and muscular the use of the skewer may be strongly recommended. The skewer is introduced at the level of the trochanter, and a figure-of-eight of elastic tubing is applied in front and behind. This method apparently arrests the hæmorrhage. It has been revived in America, and called Wyeth's method. It has been used in the Edinburgh school for a quarter of a century.

When the thigh is not very muscular the patient is laid on the sound side and a piece of bandage laid along the lateral edge of the body. A piece of tubing is then passed round the thigh, over the bandage, and as far up as possible. After the tubing has been tied the bandage is carried over it and given to an assistant to hold. The soft tissues and bone are divided below the level of the trochanter minor and the vessels tied. The elastic tubing is now removed, and the remaining portion of the femur excised by means of a vertical incision over the trochanter major. The one objection to this method is that in the case of malignant tumours too much muscle may be left. This may be avoided by making the first incision through the skin, and dividing the muscles at a higher level. This is practically an example of the racket method. Drainage is carried out through the outer vertical incision.

Amputation at the hip-joint may also be carried out by anterior and posterior flaps. The flaps are cut by transfixion. The anterior flap is cut first. The joint is opened, the head of the bone is turned out, and then the posterior flap is cut.

This method was employed in the pre-anæsthetic days on account of its rapidity.

AMPUTATIONS OF THE UPPER EXTREMITY

Hand.—Cicatrices on the grasping surface are to be avoided. A man's hand depends for its beauty and usefulness, firstly, on its breadth, and, secondly, upon the opposing power of the thumb to the fingers. Therefore, in operating on this part of the body one must avoid interfering with the breadth of the hand. In relation to the opposing power of the thumb to the other fingers it is desirable to interfere as little as possible with the muscular attachments; the operation, therefore, should as far as possible be subperiosteal.

Amputation of the Middle Finger.—The books describe a racket-shaped incision. With such an incision, when consolidation takes place, there is a tendency to dislocation backwards of the metacarpal bone. Sooner or later contraction occurs, and the breadth of the hand is lessened. There is also the objection of a cicatrix on the palm. The operation I prefer is as follows: Enter the knife at the knuckle, pass down to the web, and then along the side of the finger, cutting a large palmar flap. In cases where the flap cannot be got from the palmar aspect it may be obtained from one or other side. With such a flap there is a posterior cicatrix and no tendency to transverse contraction.

Amputation of the Fore and Little Fingers.—In these operations the head of the metacarpal bone should be left. The best way to get a covering for the head of the bone is to make a racket-shaped incision, beginning in the forefinger on the radial edge, and in the little finger on the ulnar edge. The incision is to be carried round the finger at a lower level than the web—practically at the middle of the first phalanx. This gives the most useful hand, but the projection is unseemly. When the patient does not require to use the hand much a portion of the head of the metacarpal bone may be taken off obliquely, and the hand will be smaller. The general rule is to save as much as possible.

Partial Amputation of the Fingers.—A cicatrix on the palmar aspect of the finger is to be avoided. The most satisfactory flap is a long palmar flap, but in many cases one must take the flaps where they can be got. In amputating at the first interphalangeal joint many surgeons say there will be no movement of the stump because the tendons are divided. This danger can be best avoided by fixing the tendons to the periosteum covering the bone.

Amputation of the Thumb.—The more one can save in these cases the greater will be the grasping power. Sometimes one requires to remove the thumb plus the metacarpal bone. In such cases a racket-incision with a long handle to the racket is to be made; or a method formerly employed—cutting an anterior flap by transfixion may be adopted.

Amputation of the Wrist Joint.—This operation is best carried out by making an anterior flap and turning it up, so as to get a posterior cicatrix and a stump on which the patient can bear pressure.

Amputation through the Forearm and Upper Arm.—Here no hard and fast rules need be laid down. In order to save as much of the limb as possible the flaps must be taken where they can be got. In many cases a modified circular method is the best. In some cases one can obtain a long anterior or a long posterior flap; in others, lateral flaps. In amputating immediately below the deltoid there will be less danger of pressure of the bone upon the cicatrix if external and internal flaps are made use of than if they are anterior and posterior.

Amputation of the Shoulder Joint.—Here the same method may be adopted as described for amputation of the hip. The patient is laid on his side with a bandage along the outer aspect of his shoulder, and a rubber tube is passed round the arm as high up as possible. The bandage is given to an assistant to hold. The surgeon now makes a sweep round the limb at the level of the upper third of the humerus, divides the bone, ties the vessels, and then, having made an incision from the coracoid process downwards, dissects out the head of the bone. This is practically Spence's method, modified as regards the way in which it is done. The objection to it is the same as the objection to such an amputation at the hip-joint in cases of malignant disease: too much muscle is left. The difference between the operation at the shoulder and that at the hip is this: In the latter the drainage is from the vertical part, in the former the vertical part is united completely, and drainage is made from the lower circular part. In cases of malignant tumour anterior and posterior flaps may be used, beginning at the acromion process. After making skin flaps the deltoid and the muscles attached to the tuberosities are divided. The assistant grasps the vessels which are then divided.

Amputation of the Shoulder Girdle

This is an operation which is sometimes required for malignant disease affecting the scapula where removal of the scapula alone is insufficient. A portion of the clavicle has usually to be taken away along with the arm and the scapula. The chief difficulty in the operation is hæmorrhage. For this the skewer may be of value. An incision is made through the skin in the posterior triangle of the neck, just in front of the anterior end of the insertion of the trapezius. The skewer is passed down behind the clavicle between the scapula and the chest wall, and brought out in the axilla. The elastic tubing, in the form of a figure-of-eight, is applied in front. This compresses all the vessels, and there is little trouble from hæmorrhage during the operation. Another method which I have adopted is as follows: Divide the clavicle and tie the subclavian artery. Then make anterior and posterior skin flaps, and freely remove all the disease.

Obstetric Operations

The following operations are here described:—

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See also Labour, Pregnancy.

1. Induction of Premature Labour

History and Indications.—The induction of premature labour is defined as the artificial bringing on of labour before full time, but after the fœtus has reached an age at which it is viable. The induction of abortion implies the emptying of the uterus before the twenty-eighth week of pregnancy, for a fœtus born earlier than that cannot survive.

The idea of intentionally producing premature labour was derived by analogy from parturition occurring accidentally before term. The operation was originally designed for the sake of the child only. It was of British origin about 150 years ago, being introduced in Germany some fifty years later, and in France at a still more recent date. Its morality and expediency were long questioned.

"About the year 1756, there was a consultation of the most eminent men in London at that time, to consider the moral rectitude of, and advantages which might be expected from this practice, which met with their general approbation." In 1800, Denman wrote of induction as a recognised and valuable operation in cases where pelvic deformity prevented the birth of a living child at term, and also in cases of habitual death of the fœtus in utero at or near the end of pregnancy, an indication which is now very rarely acted upon. At that time induction was not undertaken for the sake of the mother; for Denman wrote "It ought not to be performed when the patient labours under any hazardous disease." At a later date, however, it became usual to induce labour with a view to checking the progress of any disease which, while threatening the life of the mother, is due to or is aggravated by pregnancy.

To illustrate the relative frequency of the various conditions in which labour is induced in modern practice, it may be mentioned that in forty-four cases reported by S. Korscheban,[1] eleven inductions were for contracted pelvis; three for osteomalacia; fourteen for lesions of the heart; seven for nephritis; three for pernicious nausea; five for tuberculosis, and one for perityphlitic abscess. The maternal mortality was 6 per cent, this being entirely in cases where the operation was undertaken on the mother's behalf, and was in no case traceable to the operation. 79·4 per cent of the children were born living. Apart from contracted pelvis, Heyman (see below) has recently induced labour most frequently for threatened eclampsia, lesions of the heart, and tuberculosis.

METHODS.—In reviewing the various methods by which labour may be induced, it is not necessary to mention the use of agents such as ergot and quinine, for the action of all drugs is much too unreliable for this purpose. The same applies to mechanical irritation of the nipples, and other devices which have from time to time been suggested for setting up uterine contractions.

The original method of inducing labour was simple puncture of the membranes, and for many years it remained the only one in use. It is sure to be followed by labour sooner or later, but delivery is by no means always ended during the life of the child. The bag of fore-waters being absent, the fœtal head has to play the part of dilator, and is exposed to the pressure of the parts dilated during the slow progress of a "dry labour." Owing to its uncertainty as to time, and the undue risk to the child, puncture of the membranes has been given up in cases where induction is undertaken in order to allow of the birth of a living child through a narrow pelvis. In certain cases, however, where the indication is some condition threatening the life of the mother, such as eclampsia or accidental hæmorrhage, rupture of the membranes forms a useful initial step towards emptying the uterus.

Daily repeated digital dilatation of the cervix was the method which displaced puncture of the membranes. The objections to this method is that the practitioner may have to dilate the cervix daily for ten or twelve days before the onset of labour. The results, however, are excellent, and other measures may be adopted at any time if progress is too slow. In the year 1824 Professor Hamilton of Edinburgh was teaching and employing this method. Its value may be judged from the results of Moir,[2] who employed it from the year 1833 until the year 1884. During that time, he induced labour in 26 patients, eight times in one patient, five times in three, four times in one, thrice in ten, twice in three, and once in eight. Of the 72 children (twins once) 59 were born living and healthy, and 13 were still-born. The operation was thus successful as regards the child in 82 per cent of his cases. Moir induced labour 69 times without losing one mother, but the last two patients upon whom he operated died during the puerperium. He used to begin by passing through the cervix a metal rectal bougie, and turning it round so as to separate the membranes near the os. This was repeated daily until, "in the course of three or four days, but sometimes not until six or seven, the condition not only of the os and cervix, but also of the vagina, became entirely changed so as to be soft, relaxed, and dilatable, very much as at the full time." So soon as this occurred dilatation was continued with one and then with two fingers, once or twice daily, until pains began.

Vaginal douching with hot water was introduced as a mode of inducing labour by Kiwisch in the year 1836. Repeated with sufficient frequency day after day douching will induce uterine contractions, but it is a very uncertain and slow method. The constant flow of water over the part sets up an unhealthy condition of the vagina, and renders it peculiarly liable to become the seat of septic infection by removing the natural discharge and the superficial epithelium. Its employment has been recently advocated by Larwey.[1]

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[1] *Monatschrift für Geburtshülfe und Gynäkologie*, Band ii. Heft i. 1900.

[2] *Obstet. Trans. Edin.* vol. xxiii. 1897-98.

Of late years the most popular method of inducing labour has been that of Krause. A flexible bougie (not a catheter) is introduced through the cervix and pushed up between the membranes and the uterine wall until its point lies about seven inches above the level of the os internum. The portion of the bougie remaining outside the uterus is then coiled up or cut off short; and a pad of gauze is placed in the vagina in order to keep the bougie in position. When pains begin, which usually happens within a few hours, the bougie is withdrawn and labour is allowed to proceed naturally. There is considerable risk of puncturing the membrane when inserting the bougie, and the placenta may be injured and partly separated should the instrument chance to traverse that part of the uterine wall to which it is attached. These risks are naturally increased, when, as is sometimes necessary, a second bougie is inserted after waiting in vain during some hours for the onset of labour. Briggs,[2] of Liverpool, has advised the insertion of three or four bougies together at the beginning, a course which increases the rapidity of the method, but also obviously multiplies its risks. The nature of the results which may be obtained by the use of the bougie may be gathered from Heyman's[3] report of 107 cases, out of which 64·3 per cent of the children were born alive. There was no maternal mortality traceable to the operation, though the mothers died in certain cases in which the operation was undertaken owing to serious maternal disease. Leopold's average time for completing labour by this method is 80 hours 16 minutes. Brigg's average is less than half this time when three or four bougies are introduced together, and when the bougie is used, his modification should always be preferred to the original method.

In 1892 Pelzer introduced a method of inducing labour by injecting one or two ounces of glycerine through the cervix into the lower uterine segment between the membranes and the uterine wall. The glycerine is said to act in three ways: (1) As a chemical irritant; (2) by removing some of the liquor amnii by osmosis; and (3) by separating the membranes from that portion of the uterine wall surrounding the os internum.[4] This method has been said to be not only ineffective but dangerous, various inconveniences having followed its employment, namely, slow pulse, high temperature, cyanosis, hæmoglobinuria, and albuminuria. Out of thirty-five cases collected by Helme this method failed to bring on labour in only two instances, and in these two cases one patient was moribund when the glycerine was injected, while the other had already had three bougies in her uterus for several days. Four of the women died, two from eclampsia, and two from nephritis which was known to be pre-existent. Under certain circumstances glycerine is doubtless of use in favouring dilatation, but it is doubtful whether, unaided, it affords a good method of inducing labour. During the last few years very few cases have been reported in which it was used. Spinelli[5] has recently advocated another method of employing glycerine for this purpose. He packs in between the membranes and the uterine wall a strand of gauze soaked in ichthyol and glycerine.

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[1] *Archiv für Gyn.* Bd. lx. Heft 3, 1900.

[2] *Trans. North of England Gyn. Soc.* Nov. 1893.

[3] *Archiv für Gyn.* Band lix. Heft ii. 1899.

[4] The practice of separating the membranes freely by copious injections of water through the cervix was found to be very dangerous, owing to the risk of producing air embolism, and has accordingly fallen into disuse.

[5] *Archiv. Ital. di Gin.* 31st December 1898.

Very many years ago Huter caused uterine contractions by distending the vagina with a bladder smeared with oil of hyoscyamus, and the first india-rubber bags used in obstetric practice were employed in the same way. The action of a bag placed in the vagina being found to be extremely uncertain, fiddle-shaped bags, like those of Barnes, were devised in order that part of the bag might be introduced through the cervix, and might so exert direct dilating force upon the os uteri. These elastic fiddle-shaped hydrostatic dilators may be used for the induction of labour after preliminary dilatation of the cervix sufficient to admit of their introduction.

The conical bag designed by Champetier de Ribes[1] has been gaining favour during the last twelve years. It is conical in shape, the tube through which it is distended being attached at the apex, and it has a pelvic curve. Being made of strong silk covered with india-rubber, it is practically inelastic and, when filled with water, preserves its conical form in spite of considerable pressure. When the os has been dilated enough to admit two fingers the folded bag is passed upwards until the whole of its conical portion lies within the uterus. When almost filled with water it fits into the lower uterine segment, and acting as a large foreign body, it sets up uterine contractions, as a rule, within three or four hours. The bag then acts as a fluid wedge, much as the "fore-waters" do in normal labour, and transmits to the cervix and lower uterine segment the force of the uterine contractions.[2] If these are weak or absent the attendant may add to or replace them by pulling gently upon the stalk of the bag from time to time. The base of the cone is approximately of the same diameter as a fœtal head, so that when the os is large enough to allow of the bag slipping through it into the vagina, dilatation may be considered to be complete, and delivery may be rapidly ended if necessary. The main defect of Champetier de Ribes' bag lies in the fact that owing to its large bulk it is liable to displace the head, and thus tends to favour the causation of malpresentations and untoward positions of the head. The instrument has probably been used more frequently in cases of hæmorrhage and in dry labours than for inducing labour, the purpose for which it was designed. It is, however, most useful in cases in which induction must be rapidly performed, and when simpler means have failed to produce the desired effect.

Horrocks employs for induction small bags of very thin india-rubber, which closely resemble toy balloons. One of these is tied over the end of a number 6 catheter, which is then passed about two inches through the cervix so that the bag lies within the uterus. It is then filled with fluid by means of a syringe connected with the catheter by a short rubber tube. The bag acts as a foreign body, and after a time sets up uterine contractions, but this result may be delayed for several days. When once established the pains may continue naturally, or it may be necessary to maintain them by the use of Barnes' or de Ribes' bags. These small rubber balloons afford a very perfect method of gradually and slowly inducing labour, which in time may prove superior to the use of the bougie or repeated manual dilatation. They do not in any way compete with other hydrostatic dilators by which force may be directly applied in opening up the os uteri.[3]

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[1] *Annales de gynécologie et d'obstétrique*, 1888.

[2] It follows that this bag is seen to the greatest advantage when the membranes have been ruptured and the waters lost.

[3] Electricity has often been suggested as a means of inducing labour, but any current which is sufficiently strong to set up uterine contractions is so disagreeable to the patient that this method is without practical value.

Risks.—The special risks which attend the various methods of inducing premature labour have been mentioned above. Those which are incidental to the methods which are now general, or are likely to become so, are not serious, and they affect the child rather than the mother. They should, however, be remembered when choosing the method to be adopted in any case. The risks which attend the operation whatever method is employed next demand consideration. The child may, of course, be lost if labour is induced too early or too late; in the latter case the mother also is exposed to the risks of a severe instrumental labour. These accidents can only be obviated by careful calculation and measurements, and by frequent examinations made as the time for induction draws near. A lack of patience in waiting for complete dilatation of the soft parts is to blame for the death of many children, and, though obvious, it must be pointed out that for successful delivery by turning a roomy cervix is even more essential than for forceps delivery.

For the mother the main risk is that of septic infection, for whatever be the method employed, repeated and prolonged vaginal and intra-uterine interference may prove to be necessary before delivery can be brought about. Though the danger of sepsis is indeed the only one which need be seriously considered when contemplating the induction of labour, it is so grave as to forbid the operation except when clearly indicated, and in circumstances when scrupulous cleanliness can be maintained. All fussy attempts to render the vagina aseptic are to be deprecated, and the use of strong antiseptic solutions should be avoided as tending to lower the resistance of the parts to the invasion of pathogenic organisms. Vaginal douching should be limited strictly lest the natural secretions be too completely removed. A mild antiseptic, such as lysol or creolin, should be employed rather than mercurial salts or carbolic acid. All instruments used should be capable of sterilisation by boiling, and should be boiled on every occasion before use. The personal cleanliness of the operator and attendants should be secured with the same care as in major surgical operations. Above all, it is necessary to avoid bruising, tearing, or crushing of the vulva, vagina, and uterus. "A light hand is the best antiseptic," and for this reason, whenever time permits, mild and gentle measures should be adopted in the first instance, and should be given a full trial before more violent and rapid methods are employed. It is essential that all fæcal accumulations be removed from the bowel before beginning induction, and that the rectum be fully emptied every day thereafter.

Care of Child.—In arranging to induce labour preparations for the reception of the child must not be forgotten. If possible the services of a wet nurse should be secured for a short time, as the maternal supply of milk is usually somewhat delayed, and often fails altogether. An incubator must also be provided in which the child can be kept for a few weeks, namely, until the natural term of pregnancy has expired. Good "thermostatic nurses" can now be obtained in which a temperature of from 85° to 90° F. can be maintained by means of a lamp or gas jet controlled by an automatic regulator. Failing this, a box with a false bottom may be constructed, the lid being of glass, with holes for ventilation. The child, wrapped in cotton-wool, with a thermometer, is placed in the upper chamber, while the lower contains a number of hot-water bottles sufficient to raise the temperature to a proper degree. When the thermometer falls, the bottle which has cooled most is withdrawn and replaced by a fresh hot one. The temperature is gradually lowered week by week. The child should be removed from the box only for washing and feeding. If not strong enough to suck, the infant should be fed with a teaspoon, mother's milk being drawn off for the purpose when possible.

Choice of Time and Method.—The cases in which labour may be induced with propriety fall, as above mentioned, into two classes, namely: (1) those in which the operation is done mainly in the interest of the child; and (2) those in which it is undertaken chiefly for the sake of the mother. It is necessary to consider briefly the conditions under which labour should be induced, and the methods which are most appropriate in cases of these two kinds.

In cases of moderate pelvic contraction seen early in pregnancy, we may be aware from experience at previous confinements, or we may conclude from measurements, that a living child cannot be delivered by forceps or turning, while the pelvis is too large to justify Cæsarean section.

If the true conjugate be estimated at from 2¾ to 3¼ inches (or 3½ if the transverse diameter is small) induction is the proper treatment; for although some authorities prefer symphysiotomy at term to premature induction under these conditions, the cutting operation does not as yet yield results sufficiently good to justify its choice in cases which are seen early enough to permit of induction.

When it is decided to induce labour prematurely, the time at which this can be done with the greatest advantage must be carefully determined. There is little chance of rearing a child born before the thirtieth week of gestation, and in the interest of the child induction should be delayed as long as possible. It must be performed, however, soon enough to ensure that the fœtal head is smaller and its bones more plastic than at term, and should therefore be done as a rule not later than the thirty-sixth week. The object is to choose a time at which the child can be delivered with forceps without undue difficulty. It is unnecessary to induce labour so soon as to make natural delivery possible. In determining such a date it is necessary to consider the size and shape of the pelvis as ascertained by pelvimetry (which see).[1] The amount of room available in the transverse diameter is almost as important as the conjugate, and the outlet of the bony pelvis must also be considered with care. More valuable than measurement is knowledge gained by experience at previous confinements, and most useful of all is the history of previous inductions of premature labour. If the conjugate measures 4 inches, but a dead child has previously been delivered with forceps, induction at the thirty-eighth week would be justified. The table below gives approximately the times for induction suitable to certain measurements:—

Conjugate	3½ inches . .	thirty-sixth week.
	3¼ inches . .	thirty-fourth week.
	3 inches . .	thirty-second week.
	2¾ inches . .	thirtieth week.

When it is decided to induce in a certain week, it is next necessary to ascertain as nearly as possible the date of commencement of pregnancy. It is not wise to attach too much importance to statements as to the date of the last menstruation, and the date of quickening is even more fallacious. It is always desirable to measure the distance from the pubes to the fundus with callipers, and so estimate the stage to which pregnancy has advanced. The average height of the fundus above the pubes in different weeks of pregnancy is given below in inches.

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[1] Numerous attempts have recently been made to obtain by means of radiography an accurate image of the pelvic brim. The methods used have as yet proved very unreliable, and at the present time have no practical value.

Weeks	16	18	20	22	24	26	28	30	32	34	36	38	40
Inches	4	4·7	5·4	6	6·6	7·3	7·8	8·3	8·7	9	9·3	9·6	10

Two weeks before the proposed date of induction the physician should make a bimanual examination. With one hand on the fundus and two fingers of the other hand in the vagina, he must press down the fœtal ovoid until the head enters the pelvis, which it will do very easily if the calculation is correct. Subsequently the patient must be examined every week, so that induction may be deferred if possible or antedated if necessary. As soon as the head fits the brim accurately the process of induction should be begun.

The choice of method must depend upon the experience and judgment of the operator, and upon the circumstances of each case. In premeditated inductions rapidity is not the main object, and it should be the rule to begin with simple measures and employ no unnecessary instrument. The bougie may, of course, be used, in which case Briggs's method is the best; or the small rubber bag of Horrocks. But in most hands old-fashioned manual dilatation will give the best results. The cervix should first be opened with a graduated series of dilators (no anæsthetic being necessary as a rule), until a finger can be passed through the cervix. Thereafter dilatation, first with one and later with two fingers, should be made once or twice daily until the cervix gradually softens and labour follows naturally. There is a certain number of cases in which pains do not follow manual dilatation with sufficient rapidity to ensure delivery while the head is still small enough; but simple measures are enough to cause the onset of labour in so large a proportion of cases that they ought to be tried in every case before resorting to more violent means. The head should be pushed into the pelvis every day whilst dilatation is being carried out, and when it begins to be difficult to make it enter the brim, it is quite soon enough to begin more rapid dilatation. The best course is then to insert a de Ribes' bag, using, if necessary, one or two sizes of Barnes' bags, in order to gain sufficient room for the admission of the larger instrument. If the de Ribes' bag does not set up pains within six or seven hours traction may be made upon the stalk of the bag. Delivery should never be attempted when pains are completely absent, or before dilatation is complete. It is never wise to apply the forceps until the whole hand can be passed through the cervix. It is impossible to insist too strongly upon the importance of patience and judgment if induction is to be successful. The needs of each individual case must be considered, not only before beginning, but every day and hour until delivery is over.

Apart from moderate pelvic contraction there are some other conditions in which premeditated induction may be required for the sake of the child. Such are obstruction of the parturient canal by small fibroids in the lower part of the uterus, cancer of the cervix, cicatricial contractions of the vagina, and the like. In these cases time and method must be chosen, as in cases of moderate pelvic contraction. In certain conditions in which induction is undertaken on behalf of the mother there is no special need for speed, and the gentle methods applicable to induction in the interest of the child may be employed. Thus in phthisis (which see) and in some forms of cardiac disease (which see) it is sometimes possible to prolong pregnancy until the child is viable, to induce labour gradually, and deliver gently with the help of an anæsthetic, in cases in which natural labour at term could not fail to be attended by serious results.

We have referred to the induction of labour in conditions such as persistent vomiting, albuminuria, and jaundice. Regarding these and other symptoms as manifestations of the so-called pre-eclamptic state (hepatic toxæmia of Pinard), we must look upon the induction of labour where thus indicated as a prophylactic against eclampsia, acute yellow atrophy, mania, melancholia, and other serious forms of auto-intoxication (see "Pregnancy, Changes in the Maternal Organism"). It is not desirable to lose time after it is judged necessary to empty the uterus in such cases. The cervix should, therefore, be dilated at one sitting, first with solid and then with hydrostatic dilators until a de Ribes' bag can be introduced, an anæsthetic being used if necessary. In this way it is generally possible to end labour safely in from ten to twelve hours.[1] The same method should be employed when inducing labour for chorea, or for mental symptoms. In all the above cases Briggs's method may be preferred by some to the use of bags. Urgent conditions which directly endanger the life of the mother may demand even more active measures for emptying the uterus, such are eclampsia and uterine hæmorrhage due to accidental separation of the placenta and to placenta prævia. The treatment of these conditions is fully described in the articles under their names, to which the reader is accordingly referred.

Induction of Abortion.—The induction of abortion in the later half of pregnancy, but before the seventh month, differs from the induction of premature labour only inasmuch as it is undertaken solely in conditions which threaten the life of the mother. Since the child cannot be saved one objection to rupturing the membranes is removed, and this is an easy and certain means of ending pregnancy which is sufficient in many cases. If it is desired to empty the uterus rapidly dilators may be employed in the usual manner. The fifth month is perhaps the most awkward time at which to induce abortion, as at this time the placenta does not separate easily, and if it is retained it is difficult to remove, the uterus being too small to admit a whole hand, and too large for easy exploration with two fingers. In the first half of pregnancy abortion should be induced by a method which dilates the cervix without rupturing the membranes. For if the ovum is once broken it tends to come away in pieces through an os but partially opened; the emptying of the uterus is then attended with difficulty, and sepsis is very apt to occur. Tents of laminaria used singly, or several side by side, with rigid antiseptic precautions, serve the purpose best. When sufficient dilatation has been gained the tents should be withdrawn, the cervix and vagina being then packed with gauze to promote uterine action. On removing the gauze six or eight hours later the ovum may be found complete in the vagina. If part of the ovum has been expelled the uterus should be completely emptied at once without allowing time for the os to close. If the whole ovum is still in *utero* the packing may be resumed and more time may be allowed. As soon, however, as any suspicion of putrescence is indicated by the odour of the discharges, by rapidity of pulse, or high temperature, the uterus should be emptied with the fingers or the curette, after any further dilatation which may be needful has been secured by solid and hydrostatic dilators. Abortion may be induced when there is any obstruction due to abnormality of the hard or soft parts which renders the delivery of a viable child impossible, unless the mother prefers delivery by Cæsarean section at term. For this purpose the operation should be done as early as possible. Any disease justifies abortion at any time if it threatens the mother's life and can be checked by the termination of pregnancy (see "Pregnancy, Pathology of Changes in Maternal

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[1] The author induced labour in this way in eleven cases, the average time from insertion of the bag to delivery being eleven hours.

Organism"). It is necessary to add that abortion should never be induced without a consultation.

2. Forceps.

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The invention of the harmless or safe midwifery forceps has been traced by Dr. Aveling to Peter Chamberlen, who was brought to Southampton when a lad, probably in his teens, by his Huguenot father, William Chamberlen, when the family fled from Paris in 1569, in time to escape the St. Bartholomew massacres. Peter and a younger brother, before their deaths, respectively in 1631 and 1626, acquired a great reputation for their skill in effecting delivery in difficult cases through their possession of an instrument, the nature of which they kept secret and handed down to the son, grandsons, and great-grandsons of the younger brother. Palfyn, a surgeon in Ghent, proposed the use of a rather inadequate variety of forceps in 1720; but the forceps really came into use towards the end of the seventeenth and beginning of the eighteenth century, when the nature of the Chamberlen secret began to leak out. In 1773 Chapman wrote a work on *The Improvement of Midwifery*, in which he described and advocated the employment of a forceps modelled more or less on the Chamberlen pattern, and spoke of the instrument as already well known (see Fig. 1).

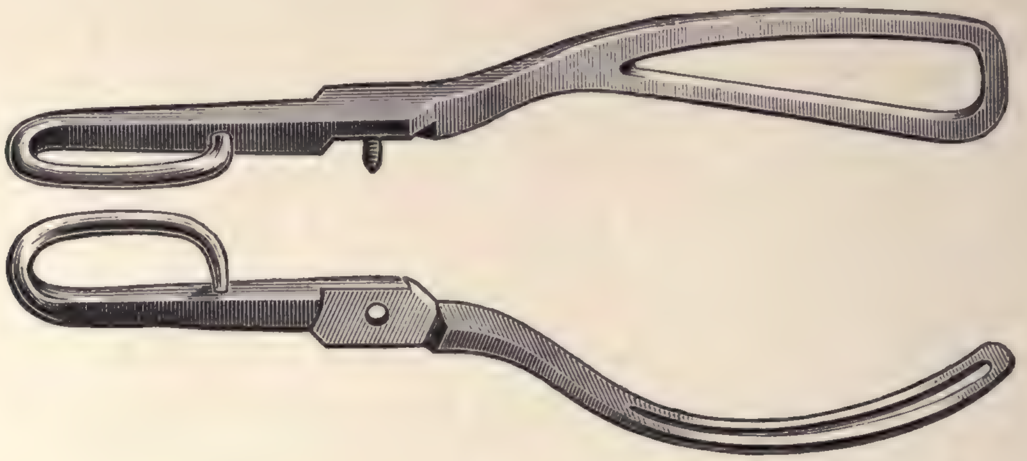

FIG. 1.

MODES OF ACTION.—Forceps may be conceived of as a pair of iron hands passed within the maternal canals so as to embrace the head of the child for its extraction.

Five different modes of action have been attributed to the instrument.

1. *Traction.*—The great and primary use of the forceps is as a tractor, and in the ordinary run of cases it effects the delivery solely by the power it enables the operator to employ of making simple traction.

2. *Compression.*—The compression influence of the forceps is one that, in most cases, we would willingly dispense with, seeing that diminution of the head in one diameter has to be compensated by increase in another. With most varieties of forceps no traction can be effected without the production of some degree of compression, the pressure on the head amounting to half the force exerted in making traction.

3. *Rotation.*—During the progress of the head under simple traction, the usual forward rotation of the occiput tends to occur, if only the operator is careful not to hinder it. Cases arise where the rotation fails, and can be brought about by a judicious working of the forceps.

4. *Leverage.*—At one time the lever action of the forceps was called into play in cases where the head failed to advance under simple traction. By swaying the handles from blade to blade, the operator could sometimes succeed in dislodging the head that was impacted in the pelvis. This pendulum movement, which is often dangerous, becomes quite unnecessary where an instrument is used that gives full power of traction in the pelvic axis.

5. *Dynamic Action.*—It has been often enough observed in lingering cases, where the parturient powers had become almost inert, that after the head began to be dislodged in the grasp of the forceps the uterine energy revived. This may be due either to the mere presence of the blades within the passages acting as a stimulant, or to the retractile change occurring in the walls of the uterus as its contents are withdrawn, or to the irritation of a new set of nerves as the head moves into a lower plane of the passages. However it may come about, this dynamic action of the instrument must be kept in mind by the operator who has applied it for delivery in a case of uterine inertia.

CONSTRUCTION.—I. *Parts of Forceps.*—The forceps in its simplest form consists of two halves—right and left, in each of which there is a Blade, a Handle, and a Lock or Joint.

1. The *Blades* are curved towards each other so as to embrace the head of the child. This curve—called the fœtal, or cranial, or cephalic curve—should have a length from the tip to its proximal end of from 5 to 6 inches, so as to be able to lie along the sides of the fœtal head in its longest diameter, and a width between the most distant part of the curves of the two side blades of 3½ inches, so as to fit the greatest transverse diameter of the average infant head. If the curve be too deep, pressure is exerted during traction only on the part of the head lying towards the tips; if the curve be too shallow, the pressure is confined to a narrow zone in the transverse diameter of the head. There should be a distance of an inch between the tips of the blades, to avert dangerous compression of the neck of the child.

In some forceps the blades are solid: more frequently, and in the best forceps, they are fenestrated. The fenestra save space and allow of a more secure grasp of the head. The blades are left and right, according as they are introduced in relation to the left or the right side of the maternal pelvis.

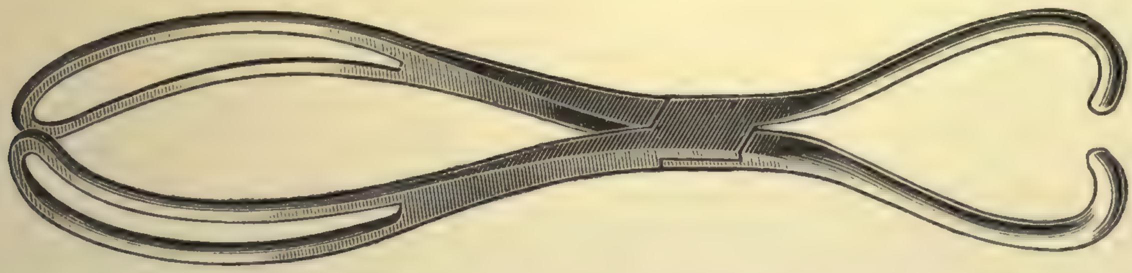

FIG. 2.—Chapman's forceps with handles ending in hooks. The first forceps figured in an English work.

2. The *Handles* are the second essential in the construction of forceps, and serve for the manipulation of the blades. In what may have been the primitive Chamberlen forceps, the proximal extremities of the handles terminated in loops like the handles of scissors or coal-vase tongs. In the forceps that came first into public use in this country, such as those of Chapman (see Fig. 2) and Giffard, the handles terminated in hooks, and up till a recent period the forceps in common use in France were made entirely of steel, with terminal crotchets through which traction was effected. Smellie had the thin steel strip of the handles covered with wood to give better power of prehension, and such handles were prevalent in the construction of British forceps for more than a century and a half. In Germany the handles

were also covered with wood, but had hooks close to the lock for purposes of traction.

3. The two blades are crossed so as to meet at the point where the blade becomes continuous with the handle. This meeting-place forms the *Lock* or *Joint* of this forceps. In the earliest type the joint is like that of a pair of scissors or coal-vase tongs, except that the pin is rivetted only into the left blade, so as to allow of its separate introduction. After the right blade is passed, the orifice at its joint fits over the pin projecting at the joint on the left, and thus the two sides are locked. The pin is sometimes made to work by being screwed into the left side, after the opening or slot on the right has been fitted over it. This form of lock is commonly found variously modified in French forceps. In Germany the Brunninghäusen lock is preferred. In this a button and stem are found on the left blade, and a notch on the right fits on the stem and forms an excellent joint. In Great Britain forceps are usually made with the Smellie lock, in which the blades mutually fit into grooves on the opposite handles at their crossing, so as to allow of their easy locking (see Fig. 3).

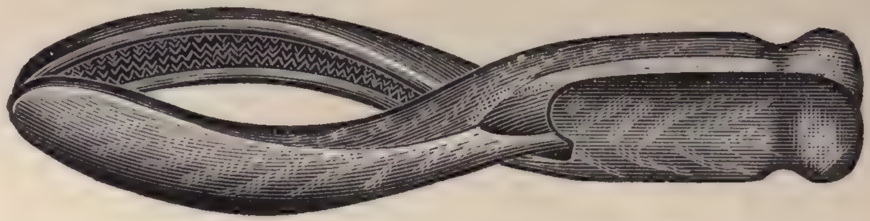

FIG. 3.—Smellie's wooden forceps, showing the "Smellie lock."

II. *Curves of Forceps.*—Forceps so constructed are straight from tips of blades to handle-ends when viewed from the side. They have only one curve to allow of the blades adapting themselves to the rounded head of the child.

1. *The Cephalic Curve.*—This is found in every forceps, and enables the practitioner to lay hold of the head of a child lying low in the parturient canal for its extraction. For cases where the head is arrested farther up in the passages, attempts were made to get access to it by lengthening the distance between blades and handles. But the forceps were still straight, and however long the shanks or stems might be, it was impossible to get a satisfactory grasp of the body that had to travel through a curved canal. The head was apt to be seized only by the part lying close to the back wall of the pelvis, and when traction was attempted the forceps slipped. If the practitioner tried to carry the points of the blades forward towards the symphysis to get a fuller grasp of the head, then the shanks or the lock of the instrument were found to be crushing the perineum. It became evident that to grasp and guide the head through the curved canal the forceps must themselves be curved.

2. *The Pelvic Curve.*—Pugh and Smellie in this country both independently recognised the importance of having the blades curved, with their tips turning forwards for adaptation to the pelvis, and nearly simultaneously proposed the employment, at least in special cases, of forceps having a pelvic curve. But it was Levret in Paris who first published a memoir describing forceps with a "new curve," which made it possible to seize the head at the pelvic brim or at any lower level, and to extract it with the greatest safety to the mother in the proper line of descent through the maternal passages. There may have been others besides who improved forceps in this direction, but it was the clear demonstration of the value of the pelvic curve made by Levret that led to the general introduction of the double-curved instrument.

Forceps by Pugh, Wallace Johnston, Mulder, and others were contrived with what was called a "perineal curve." In these the shanks were slightly recurved just above the lock, with the view chiefly of avoiding the danger of pressure on the perineum. But they were not widely used, and even after the value of the pelvic curve had been demonstrated practitioners continued to make use mainly of straight forceps, which were most easily and often secretly applied, and were usually effective in the extraction of the head lodged on the pelvic floor. Some obstetricians, even after they had recognised the necessity of using the double-curved instrument for what were regarded as "high" or "long" forceps cases, would still use a short straight pair for their "low" or "short" forceps cases. After anæsthesia came in to give the operator more freedom in the application of forceps, the smaller straight instrument, that was only applicable to a head at the outlet, gradually gave place to the longer curved instrument that could grasp the head at any level in or above the pelvis, and that could pull the head through the outlet with less danger to the perineum. The more it was used, however, the more clear it became that an instrument with a pelvic curve had two drawbacks when traction was made through straight handles. In the first place, some of the expended traction power was lost, because the pull was not exerted directly in the line of the chord of the blade-curve, which represents the line of direction for the descent of the head; and in the second place, some of the force was misdirected, tending to press the head against the symphysis pubis, and thus favouring a slipping of the blades off the infant's head (see Fig. 4).

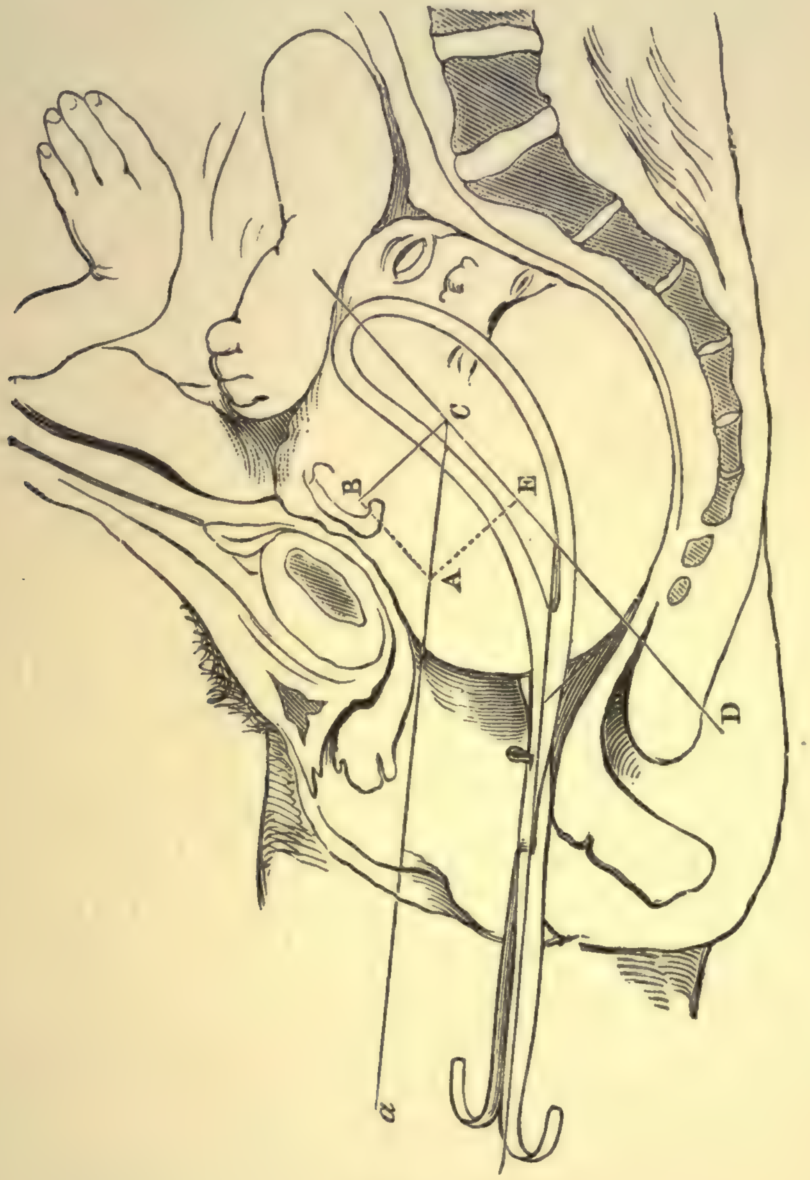

FIG. 4.

3. *The Compensation Curve.*—In 1860 Professor Hubert, of Louvain, who very clearly demonstrated the disadvantages of the double-curved forceps, proposed to remedy their defect by bending back the free extremities of the handles at a right angle in order to correct the line of traction. In

1868 Dr. Aveling, of London, had forceps constructed with what he called a "handle curve," in which the rounded compensation curve of the handles gave the instrument on side view a sigmoid aspect. Such an instrument, although somewhat more difficult of application than the straight-handled forceps, was better adapted for allowing the normal descent of the head when traction was made at the ends of the recurved handles. But they never came into general use, and their value was superseded when in 1877 Professor Tarnier, of Paris, showed that the correct traction could be most certainly attained through curved rods jointed to the heels of the blades and pulled on by a traction bar attached to their free extremities (see Fig. 5). Tarnier demonstrated that when traction was made through jointed rods with the necessary compensation curve, there was not only no loss of force and no misdirection of force, but further, that as the head changed its direction during its transit through the curved canal, this change in its direction would be indicated by a forward movement of the application-handles. For these application-handles, keeping the head fixed in the grasp of the blades by means of a screw placed close below the lock, were free to change their direction with the changing movements of the head, and so gave a guide to the direction in which at any moment traction should be made. Forceps constructed on this principle are found to be possessed of other advantages. The operator expends no energy in squeezing together the forceps handles, and as he pulls simply on the traction bar his muscular sensibility remains unimpaired, and he is better able to judge of the amount of force he is expending. There is no undue compression of the head in one direction, with tendency to elongation in another, so that the changes in configuration of the head more nearly resemble those seen in a head expelled by natural efforts. As the head is drawn down in the axis of the canal there is no unnecessary injurious pressure on the maternal structures, and as the head is not dragged against the symphysis pubis it is not so liable to elude the grasp of the blades. Rotation of the head in occipito-posterior cases will usually occur spontaneously under steady traction with the traction-bar; where rotation fails it can be aided by grasping the application-handles (see Fig. 6).

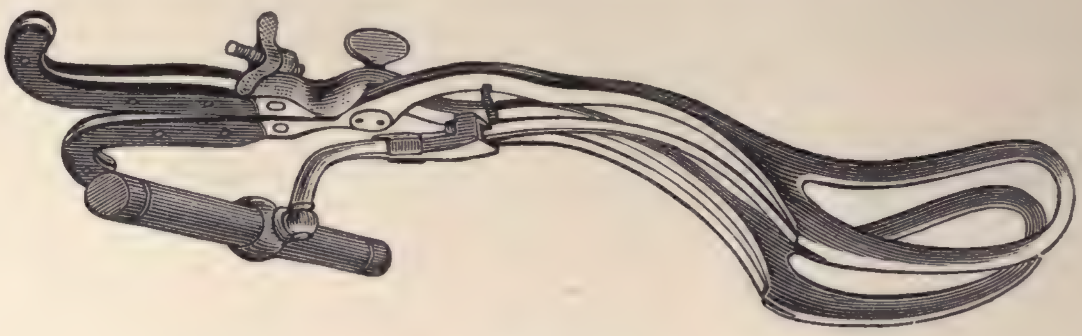

FIG. 5.

INDICATIONS FOR USE.—Indications for the use of the forceps arise either in delayed labours or in labours more immediately dangerous.

A. DELAYED LABOURS.—There is a fault in one or more of the factors of labour; and when two or even all the three factors are seen to be faulty, it is always right to seek to determine in which of them the fault originated and is most pronounced—whether (1) in the Powers, (2) in the Passages, or (3) in the Passenger.

1. *Fault in the parturient Powers, primary or secondary, or both.*

(1) *In the Uterine Power.*—The uterine muscular fibres may be in a condition of atony or of spasmodic irregular contraction, or their force may be misdirected from some obliquity of the organ.

(2) *In the Accessory Powers.*—There are cases of weak muscularity in the abdominal muscles, or paralysis, or exhaustion, that may render the patient unable to further the involuntary action of the uterus by her straining efforts. More frequently some thoracic mischief renders such efforts undesirable, and the practitioner has to supply the lack of parturient power by traction on the head of the child with forceps.

2. *Fault in the parturient Passages.*

(1) *In the Soft Canals.*—The forceps is not a good means of hastening delivery in cases of rigidity of the *cervix* uteri, though it has been thus employed. When the head is pulled through the imperfectly dilated os uteri the lips are very apt to be lacerated. But the instrument is often serviceable where the *vaginal walls* are narrowed from any cause, and again in many cases where there is delay from the rigidity of the *perineum*, or narrowness of the pudendal aperture.

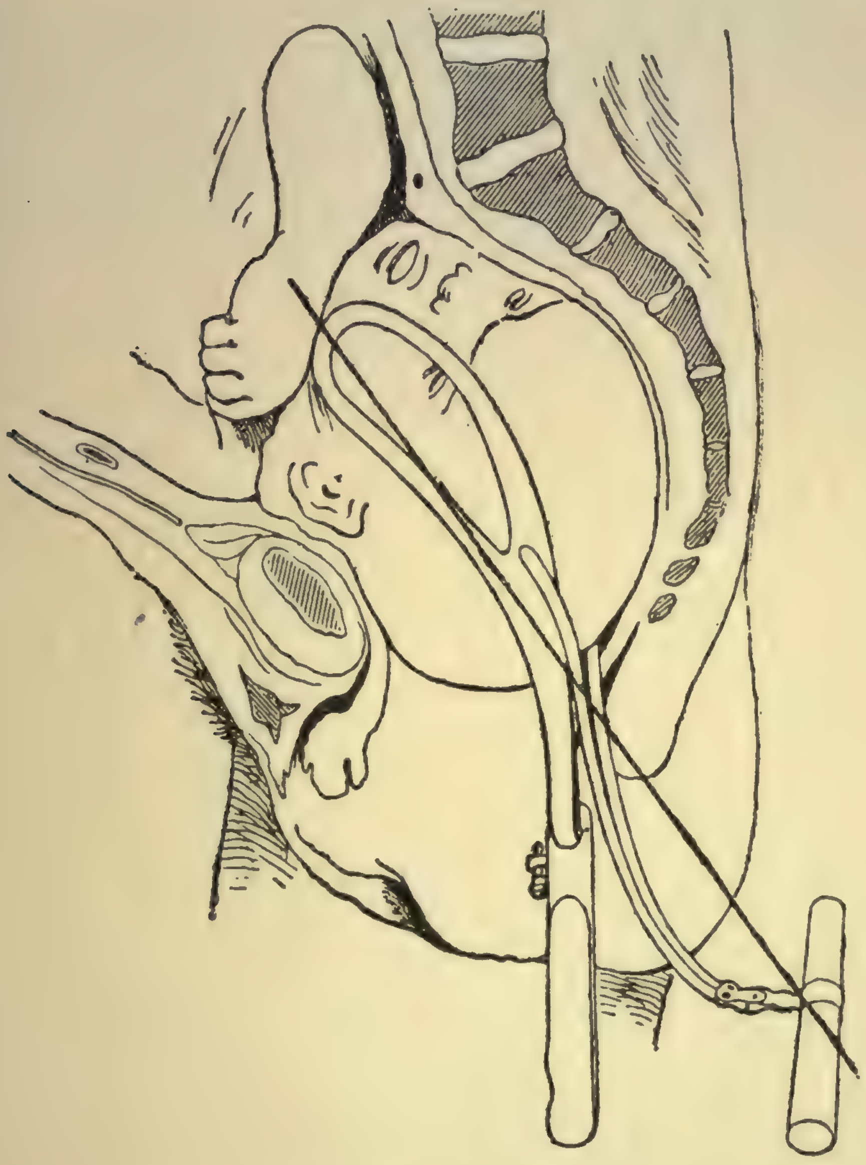

FIG. 6.

(2) *In the Hard Canals.*—Pelvic contractions form a large contingent of the cases where the practitioner effects delivery with forceps. The range of contraction in the brim conjugate where the forceps is available is from 4 inches to 3¼ inches, or, where the head is not too large, to 3 inches. If the pelvis is of the justo minor type, the dip of the hind-head, indicative of a marked degree of head-flexion, and the position of the head with its long diameter in the right oblique of the pelvis, give opportunity for the perfectly safe application of the blades along the two sides of the head. Where the pelvis is flattened and the head is placed in the transverse diameter of the brim, care has to be taken lest the blades be applied in the line of the occipito-frontal diameter and a dangerous degree of depression be produced.

In cases of coccygeal anchylosis, of funnel-shaped pelvis, or where the space is encroached on by tumours to a moderate degree, forceps can frequently be used to bring the head past the contracted plane.

3. *Faults in the Passenger.*

(1) *Large Size of Head.*—If we meet with a patient who has had one or two labours that were strictly natural, requiring the use of the forceps in a subsequent confinement, the cause of the difficulty is likely to be found in the greater bulk of the body passing, and notably in the increased size of the fœtal head. The increase in bulk may be simply the larger size of the male over the female head, or of an unusually large child of either sex, as is seen in some cases of protracted gestation. Or the head may present such a degree of ossification of the bones as to interfere with the moulding which allows of the expulsion even of a tight-fitting head under natural efforts. In these cases the head comes down with the occiput and triangular fontanelle markedly depressed—the large head finding its way through a normal pelvis, as the normal head makes its way through an undersized pelvis, with an exaggerated degree of flexion. Such enlargements of the head form a very fair group of cases for extraction with the forceps; but the instrument becomes dangerous in its application to cases of morbid enlargement, as in hydrocephalus. It is not easy to define the degree of enlargement at which danger begins; but in any case where the operator has satisfied himself that he has not taken an antero-posterior grasp of the head, and yet finds that the handles are not easily approximated, he may be sure that to persevere with the use of the instrument will be dangerous both to child and mother.

(2) *Malposition of the Head.*—Where the head in one of the posterior positions fails to make progress, forceps will often serve to bring about its descent and rotation; and where the occiput has rotated backwards it often becomes necessary to extract the head artificially.

(3) *Malpresentation of the Head.*—When we meet with a brow or face presentation at the commencement of labour, and have reason to distrust the natural powers, we may give mother and child the best chance by turning as soon as the cervix is fully dilated, or as soon as possible after the membranes have broken. But where the head so presenting has come into or through the brim and is delayed in the pelvis, we must have recourse to forceps. Care has to be taken in these face cases to apply the blades to the sides of the child's head, otherwise the points of the instrument may easily do serious damage to the structures in the infant's neck.

B. DANGEROUS LABOURS.—Special danger may arise calling for immediate delivery, and the forceps gives us the control of the labour.

1. *Maternal Complications.*—In many cases of labour complicated with utero-placental hæmorrhage, with rupture of the uterus, with convulsions, chest disease, syncope, etc. the artificial delivery that is urgently indicated can be most safely effected, both for mother and child, with forceps.

2. *Fœtal Complications.*—Again the instrument is invaluable in cases of irreducible prolapsus funis, when the waters have escaped for some time and the head is entering the pelvis, as well as in some cases of malformation of the infant.

MODE OF EMPLOYMENT.—1. *Preliminary Measures.*—A practitioner having made up his mind that forceps delivery is necessary in the interest of the mother or child or both, (1) should intimate to the responsible attendants his intention to employ the instrument, and whilst he is warranted in explaining the safety of the operation as regards the mother, he (2) should be cautious in his prognosis as to the condition of the infant. (3) His instrument should be sterilised, warmed, and greased on the outer surface of the blades with an antiseptic ointment. (4) He should ascertain that the bladder and bowel of the patient are emptied, and with the patient anæsthetised, (5) he should have her placed across the bed, on her left side, with the knees bent up and the nates brought to the edge of the bed. The delivery may be completed with the patient in this position, though sometimes he will find it easier to extract the head if the patient be placed supine. (6) Before proceeding with the application of the blades, he should make a further vaginal examination with the four fingers of the right hand, so as to assure himself of the precise position and relations of the head, and feel where there is most space for the entrance of the instrument.

2. *Introduction of the Forceps.*—(1) The left blade should be introduced first, and the practitioner who would save himself the uncertainty that sometimes comes on a man at this moment as to which is left and which is right, ought to provide himself with a pair of forceps with "Left—First" stamped on the left blade. (2) The fingers of the right hand, which have been examining the relation of the head to the passages, are used to guide the tip of the left blade, which is held in the left hand and applied to the left side of the pelvis. (3) The introduction should be begun immediately after the cessation of a pain. The practitioner may succeed in applying both blades before the recurrence of another contraction. If a pain comes on he must suspend the attempt to push on the blade during the continuance of the pain. (4) The instrument is to be insinuated gently, and if it meets with resistance it must be withdrawn and its direction altered. (5) The tip of the blade is to be kept in contact with the fœtal head rather than with the vaginal wall. (6) Each blade is to be entered and applied in the proper axis of the pelvis. (7) The concavity of the blade is to be adapted to the convexity of the fœtal head. (8) When the first blade is fully introduced it is to be kept *in situ* with the thumb and last two fingers of the left hand, while the index and medius of the same hand are applied to the head to guide the right blade into the passages. (9) The right blade, with the traction-rod swung forward, is held in the right hand and introduced at right angles to the left, pointed at first towards the hollow of the sacrum, and carried round the head until it comes into complete antagonism with its fellow. (10) The handle of each blade is grasped by its homonymous hand to effect the locking, the right rod is swung back, and the fixation screw adapted but not tightened.

3. *Extraction of the Head.*—(1) The application handles are grasped with one hand, and the screw is fixed with the other at the point where safe and sufficient compression of the head is secured. (2) Traction is made with the traction handle during pains; or, if no pains are present, at intervals. (3) In making traction the traction rods are kept constantly parallel with the shanks, thus ensuring progress of the head in the proper axis of the canals. (4) After each tractile effort the screw is slackened, but not unshipped, and during the interval the operator ascertains what progress the head has made. (5) In occipito-posterior cases, when the forward rotation of the occiput fails to occur under the simple traction, the rectification is aided by grasping the forceps by the application handles. (6) At the outlet, while traction is made with the right hand, the perineum may be supported with the left. (7) The head is made to distend and pass through the pudendal orifice very slowly, the uterus being allowed to complete as often as possible the expulsion of the head and always of the body of the

infant. (8) Immediately after the birth of the head the screw must be slackened, the right traction rod freed from the locking plate, and the right and left blades removed successively.

Dangers of Forceps.—Although the forceps is safe in principle, both to mother and child, there are dangers to both attendant on its use which are reduced to a minimum with a properly constructed instrument properly applied and worked. The practitioner who has these risks clearly in view is most likely to avoid them.

I. *To the Mother.*—The vaginal walls or roof, or the cervix uteri, may be torn with the tip of the blades during their introduction. The vaginal walls may be bruised at the sides during rotation of the occipito-posteriorly placed head. The nerves of the pelvis have sometimes been damaged, and the ligaments strained at the various articulations. The most frequent mischief is produced when the head is extracted too rapidly or in a wrong direction through the pudendal aperture, when the perineum is more or less deeply lacerated, or the labia pudendi are bruised and torn. But greater than all the risks attendant on the use of forceps is the risk incurred by delay in their application in cases where the head is lodged for hours in the pelvic cavity.

II. *To the Child.*—The greatest danger to the infant lies in such a grasp of the head as involves undue compression, when bruising of the soft parts and even fractures of the skull may be produced. Sometimes the neck of the child is squeezed between the tips of the blades, and where the cord is coiled round the neck one of the blades may be found to have produced a fatal compression of it. Not infrequently the face of the child is seen to be the subject of a Bell's paralysis resulting from compression of the facial nerve, and usually passing off within ten days or a fortnight.

Spondylotomy.—See "Embryotomy."

3. Vectis

When the midwifery forceps was coming into general use in the end of the seventeenth and beginning of the eighteenth century, Roonhuysen, Ruyschl, and the other chiefs of the Amsterdam Academy, were known to be making use of an implement for promoting labour, the nature of which they kept secret. They were enabled to obtain an enactment that prohibited anyone from practising midwifery in Holland who had not purchased their secret, which was a source of revenue to them until it was made public in 1753 by Visscher van der Poll. The instrument they employed, with various modifications, speedily came into general use under the designation of the vectis or lever, and for more than a century competed with the forceps as a means of promoting the advance of the head in cases of tedious and difficult labour. It was used sometimes as a lever of the first order with the mother's pelvis, or, better, with the operator's left hand as a fulcrum; sometimes as an extractor worked as a lever of the third order. It is in the latter fashion that its employment has recently been advocated by Dr. Bartlett of Chicago, the instrument being made with a handle flattened and so elongated as to rest on the forearm as a fulcrum near the elbow. Sometimes it has been used as a single blade of forceps, one of the operator's hands taking the place of the second blade. It has been claimed for it that it is easier of application than forceps and less likely to do harm in extracting, whilst it is often efficacious in aiding rotation in occipito-posterior cases. It has been applied chiefly over the occiput, but may be adapted to the sides of the head or to the brow or face. In some cases its place of application is moved from one part of the head to another. It is, of course, only available when the uterus is in action; and because of its tendency to slip, and the ease and safety with which in most cases delivery can be effected with forceps, the vectis has fallen almost completely into desuetude. The "levier-prehenseur-mensurateur" proposed by Faraboeuf is in reality a variety of forceps which owes what efficacy it may possess to its second blade.

4. Version

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The operation of version or turning consists in the artificial substitution of one presenting part by another. This comprises either the substitution of one pole of the fœtus by another, or the conversion of oblique presentations into the presentation of one or other pole so that the long axis of the fœtus and uterine cavity correspond.

VARIETIES.—From the definition of the operation it must be apparent that there are two varieties: (1) Cephalic version, in which the head of the fœtus is made to present; (2) Podalic version, in which the breech or feet are made to present.

GENERAL INDICATIONS.—The operation is indicated:—

1. In all shoulder and oblique presentations.

2. In cases of placenta prævia, where a large area of placenta presents.

3. In prolapsus funis during the first stage, when reposition of the cord cannot be accomplished.

4. In mento-posterior face and brow cases when rotation backwards of the chin is feared.

5. When rapid delivery is required and can be most expeditiously performed by changing the presentation.

6. It used to be extensively employed before the introduction of axis traction forceps and is still recommended by some, in flat pelves with a conjugate vera over three inches.

METHODS.—The operation may be performed by three methods, known respectively as the external, bipolar, and internal.

External Method.—To perform this operation the patient is placed in the dorsal position with the shoulders raised and knees flexed. The hands of the operator are placed externally over the bare abdomen, one on each pole of the fœtal ovoid. By a series of moderate impulses with the respective hands in opposite directions during the intervals of uterine contractions, the fœtus may be made to revolve on its transverse axis till one or other pole is brought to present. The presentation having been altered, it is well to maintain it

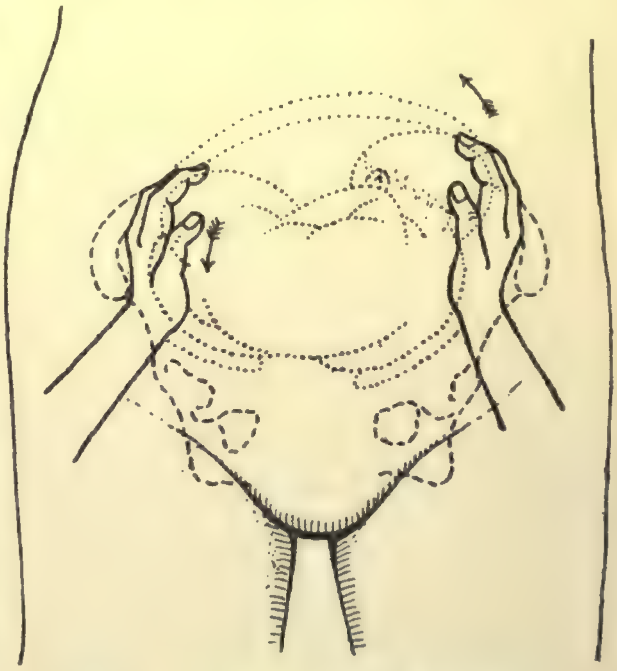

FIG. 1.—External Version (Schäffer).

in its newly-acquired situation by means of a binder. Unfortunately, this method of version, which is practically without risk, can only be performed under favourable conditions which are rarely met with when required. Not only must the liquor amnii be wholly present and in considerable quantity, but it is rarely possible after labour has commenced and the presenting part thus fixed in the pelvis.

Should shoulder or pelvic presentations be noticed before labour has commenced, an attempt at their conversion into cephalic presentations should unquestionably be made by this method, but after the onset of labour the fixation of the presenting part prevents its ready substitution in this manner, and the direct employment of the bipolar method should be undertaken.

Bipolar Method.—This method of version, as introduced by Braxton Hicks, was undoubtedly one of the greatest advances in obstetric science during the last century. It enables the accoucheur to perform version early in labour when, as in shoulder presentations, it is easy and safe; but perhaps still more important is this method in the early stages of placenta prævia, before great separation of the placenta and consequent hæmorrhage has occurred.

It is carried out by both hands, one externally and the other internally, acting simultaneously on different poles of the fœtus, and has therefore been named by some authors the "Combined Method." For its performance it is necessary that there be considerable mobility of the fœtus in utero, practically, in the majority of instances intact membranes and consequent entire liquor amnii.

Before operating the patient should be anæsthetised, as this is beneficial in controlling the force of the uterine contractions and permitting the painless introduction of the whole hand into the vagina.

The patient may be placed in the dorsal or left lateral position. One hand, preferably the left, having been carefully disinfected and lubricated on the extensor aspect, is in a cone-shaped manner slowly introduced into the vagina by a rotatory movement—any pressure necessary being directed backwards on the distensible perineum. On the cervix being reached two or three fingers are introduced to act on the presenting part as required, while the other hand is placed externally over the abdomen ready for coincident manipulation. The two hands can then move the extremities of the child in different directions. These manipulations are to be conducted only during the intervals of pains. Thus, in the conversion of a vertex presentation into a breech the internal hand will be made to push the presenting part upwards to free it of the pelvic brim, and then in the direction of the occiput, while at the same time the external hand will depress the breech in the direction of the feet. Rotation of the fœtus is thus made to occur through the smallest arc. In like manner, in shoulder cases the presenting shoulder may be pushed in either direction, according to whether a cephalic or podalic version is desired, the external hand acting on the breech or head as is considered more efficacious.

The advantages of the "combined" over the "external" method chiefly rests with the readiness by which the fixed presenting part can be freed from the pelvic brim after labour has commenced. As a mode of delivery it is invaluable in placenta prævia when the cervix is but partially dilated. Here podalic version can be readily performed and a foot dragged through the cervix to act as a plug against further hæmorrhage. It is also of incalculable value in the easy or early rectification of shoulder presentations. Unfortunately it cannot be performed after the liquor amnii has drained away, and now the only method that is applicable is the

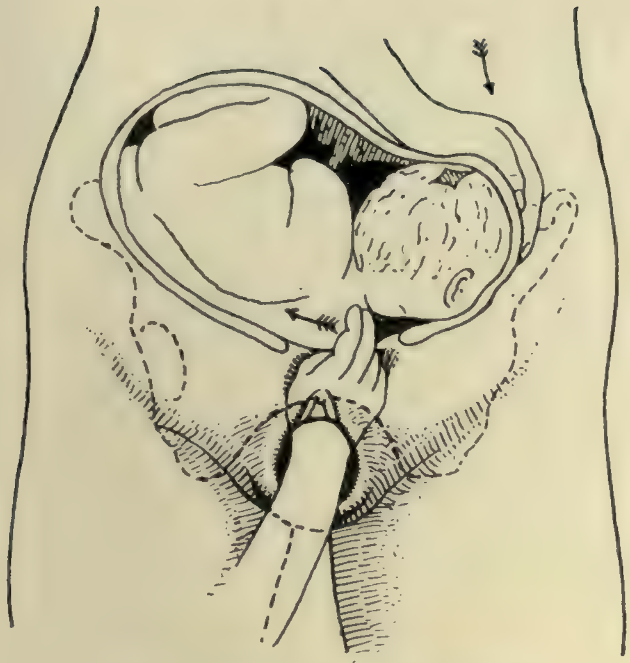

FIG. 2.—Bipolar cephalic version.
(Schäffer modified.)

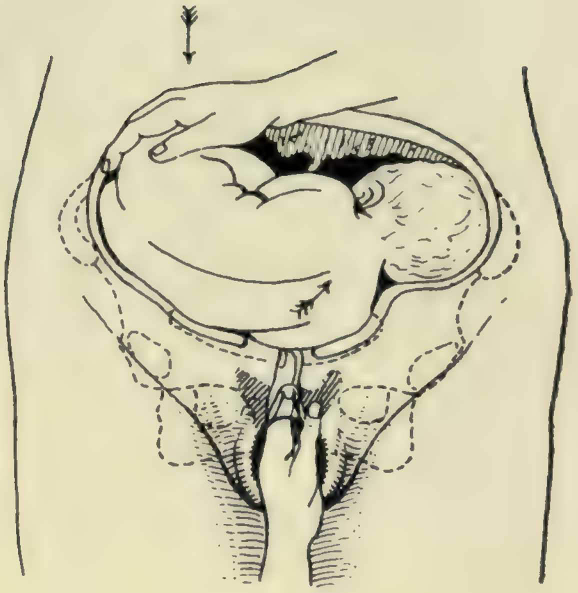

FIG. 3.—Bipolar podalic version, 1st stage.
(After Schäffer.)

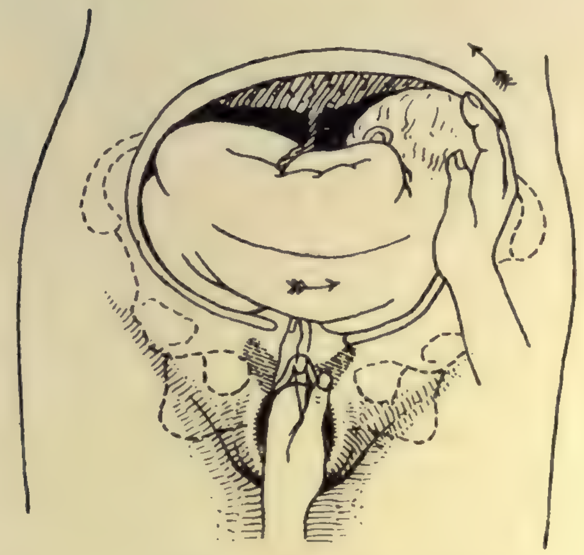

FIG. 4.—Bipolar podalic version, 2nd stage.
(Schäffer modified.)

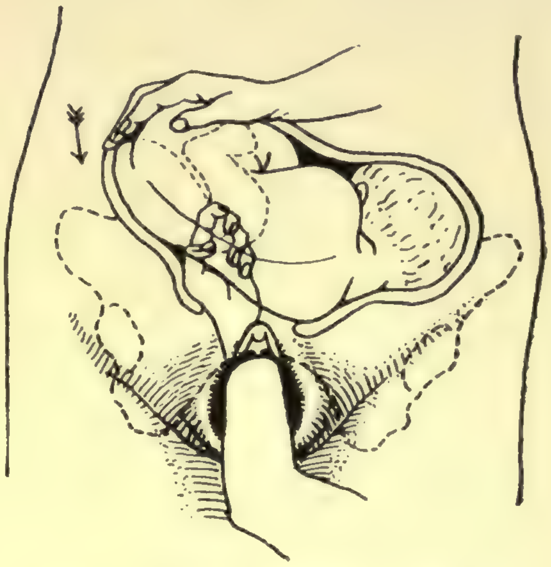

FIG. 5.—Internal version, 1st stage.
(After Schäffer.)

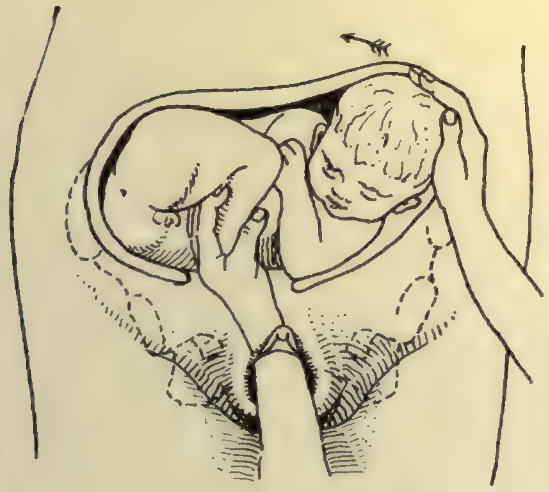

FIG. 6.—Internal version, 2nd stage.
(After Schäffer.)

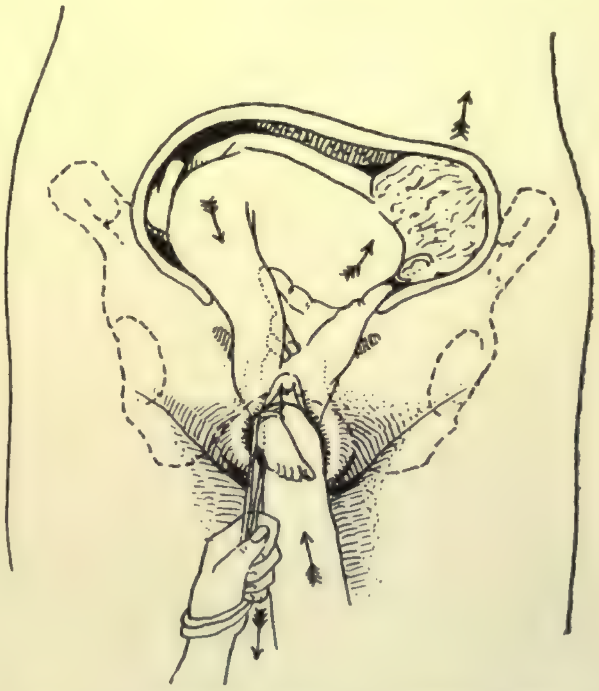

FIG. 7.—Internal version in impacted case
assisted by loop. (After Schäffer.)

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Internal Method.—From a teaching point of view the term "internal," in contradistinction to the "combined" method of turning, is unfortunate, as it conveys the idea that manipulation is wholly intra-uterine, when in reality the external hand placed over the exterior plays as important a rôle as in both of the preceding methods described.

The operation essentially consists in the introduction of the entire hand into the uterine cavity, by which means one or other pole of the fœtus is grasped and made to present. From the difficulty in seizing the fœtal head internal version is usually podalic, although the cephalic is now more frequently attempted than formerly. This method of operating is of great antiquity, and, until the recent perfecting of forceps, was by far the most common mode of artificial delivery. It is the only method of version applicable after the liquor amnii has drained away.

Method of Operating.—The patient should be anæsthetized, so that uterine relaxation may be as complete as possible, and at the same time the absence of any movement on the part of the patient facilitates the ready accomplishment of the operation and minimises risk. Having placed the patient in the dorsal or left lateral position, according to the operator's fancy, he then, after having thoroughly disinfected his hands, proceeds to introduce one slowly into the uterus.

The choice of hand has been and is a much controverted subject, and must be left very much to the judgment of each individual operator without laying down any binding rule; but generally it may be said that in dorso-anterior positions the left hand, and in dorso-posterior positions the right hand, seem to be more readily applicable than *vice versa.* The introduction of the hand into the vagina is to be done by a rotatory movement, the fingers previously having been arranged to form a cone. All attempts at introduction or manipulation whatsoever must be confined to the intervals of pains; during uterine contractions the hand must remain quiescent and be flattened out as much as possible.

Having reached the os externum which, if it be large enough to admit of the passage of the hand, the movement upwards is continued in a rotatory manner until the uterine cavity is entered. Should the membranes be unruptured the fingers must be bored through them at the most dependent part, and the hand at once pushed into the uterus to block the entire escape of the liquor amnii. The hand should now be more or less flattened out and carried along the ventral aspect of the fœtus until the part desired to catch is reached. During the introduction of the internal hand the other hand must be placed over the uterus externally to form a counter-pressure to any forcible internal manipulation, so that overstretching of the vaginal attachments of the uterus may be prevented and at the same time assist in bringing the fœtal parts nearer the inside hand.

In podalic version a much debated point exists as to which foot or knee is to be grasped. In dorso-anterior cases it is almost universally agreed that either which is first met with should be seized, but in dorso-posterior positions there is much difference of opinion among authorities. In the majority of instances it is found that the part which is grasped will rotate anteriorly when pulled on, and thus, by grasping the upper or further knee, the entire fœtus will be made to rotate on its long axis, which may assist greatly in the dislodgment of the presenting part should it be already fixed (Figs. 5 and 6). Having seized the part desired, slow, gentle, and steady traction must now be made while the opposite pole is pressed in the opposite direction by the external hand. During pains all manipulations are to be avoided. After version has been completed and the foot dragged into the vagina, the expulsion should be left to nature and treated as an ordinary breech case, unless special indications are present for immediate delivery.

With the membranes immediately previously intact, or but recently ruptured, version is usually an extremely simple operation, but in cases where the liquor amnii has been for long drained away and the uterus firmly retracted on the child, the difficulties and risks are very great and sometimes insuperable. Here the lower lateral segment will be found extremely thinned, and any forcible manipulation must result in rupture. It need hardly be stated that in these cases the greatest care and gentleness must be exercised in the manœuvre. When the shoulder is impacted in the pelvis turning is much expedited by the application of a noose of tape round the ankle, by which traction may be made, while at the same time the shoulder should be gently pushed in an upward direction (Fig. 7).

Should, from thinning of the uterus, rupture be feared decapitation of the child is to be preferred. This, fortunately, however, is rarely necessary.

The dangers of version are mainly sepsis and rupture of the uterus, both of which are avoidable, the first by careful attention to antisepsis and asepsis, and the second by the recognition of existing conditions, which must lead every intelligent practitioner, from his knowledge of general principles, to exercise the necessary amount of caution which is required in dealing with a mechanical problem where the conditions must vary in each individual case.

PRACTICAL RULES FOR TURNING.

1. If labour not yet begun, try external method.
2. If labour commenced, membranes unruptured, and os uteri slightly dilated, try external method.
3. If membranes unruptured and os uteri sufficiently open to admit three fingers, try either external or bipolar.
4. Bipolar method specially indicated in placenta prævia with os uteri partially open.
5. If membranes unruptured and os dilated sufficiently to let hand through, try bipolar method first in all cases if no hurry; if hurry necessary perform internal version at once.
6. If membranes ruptured internal method is alone available.

5. Embryotomy

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Embryotomy (Gr. Ἔμβρυοτομια) and *embryulcia* (Gr. Ἔμβρυουλκια) are terms alternatively applied from ancient times to delivery brought about through mutilation of the infant. The former term is expressive of the procedures that imply the cutting to pieces (Gr. *τήμνο*) of the embryo or fœtus, whilst embryulcia expresses the dragging out (Gr. ἕλκω) of the mangled remains. Cases of embryotomy are sometimes described as cases of craniotomy, cephalotripsy, etc. according to the method adopted for securing the delivery. For ages physicians and surgeons who were called in to see women in difficult labours knew no other way to save the mother but to sacrifice the life of the child, hacking it to pieces, fracturing its bones, and extracting it with hooks or pincers. Version, the Forceps, Induction of premature labour, Symphysiotomy, and the Cæsarean sections, have limited the range of application of embryotomy, so that some obstetricians have expressed the opinion that improvements in these other operations should enable the practitioner to dispense altogether with a process that necessitates the death of the infant. We have not yet, however, attained to this desirable ideal, and the practitioner still meets with cases both of head and of trunk presentation where he finds himself warranted and even compelled to have recourse to embryotomy.

A. In Head Presentations

Indications.—The conditions that justify or require the sacrifice of the life of the child are usually to be found in such disproportion between the passages and the passenger that the latter cannot be passed through unless it be diminished in bulk.

I. *Fault in the Passages.*—There are different forms of contraction of the *Bony Pelvis,* such as the rickety, where the contraction is mainly at the brim; the kyphotic, where the outlet is narrowed; the osteomalacic, where the whole canal is narrowed. In any of these the practitioner may find himself shut out from delivery by the alternative operations, and obliged to have recourse to perforation of the head. The range of brim contraction in the conjugate diameter would be between three and a quarter and two inches. If the contraction is in the transverse diameter there would be corresponding degrees at the outlet. Sometimes the obstacle is due to a morbid condition of the *Soft Canals,* as when there is cancer of the cervix or cicatricial contraction of the vagina, or the space is encroached on by a uterine or ovarian tumour. In a maternity hospital such cases would preferably be treated by some of the Cæsarean methods; but the general practitioner may give his patient the best chance of recovery by lessening the size of the child's head.

II. *Fault in the Passenger.*—Undue size of the fœtal head, or a brow or face presentation in a slightly narrowed pelvis, or locked twins, may necessitate the operation.

III. *Complex Labours.*—In some cases of convulsions or hæmorrhage or rupture of uterus, where the os is still imperfectly dilated, the mother may have a chance of survival if the fœtus can be diminished in size and extracted with less distension of her parts. Where the infant is already dead, as in cases of neglected prolapsus funis in a pelvis measuring something under four inches in the brim conjugate, the dangers to the mother will be lessened by reducing the bulk of the head.

As a rule, head-perforation is unwarranted in a woman who has previously given birth to a living child by the natural efforts, or who has been delivered by the simpler operations of turning or the forceps. But malacosteon may cause an increasing difficulty, or tumours may develop; or the head of the later child may be of larger size or present less favourably; or a complication may arise requiring the graver interference.

Stages of the Operation.—There are three distinct stages or steps in the procedures involved in the complete artificial delivery of a child that has the head reduced in size.

I. *Perforation.* — The operator must first make an opening in the presenting part of the cranial vault.

(1) *Instruments to be used.*—1st, In a case of hydrocephalus with wide sutures it will usually be best to puncture simply with a fine aspiratory trocar. 2nd, In the more frequent conditions the bones may be pierced with a Knife, Bistoury, or Spike, of which many varieties have been contrived, sometimes curved, sometimes straight, sometimes sheathed. 3rd, More effectively the opening may be made with a pair of long, strong Scissors, provided with shoulders, which prevent them from sinking too far through the skull. When the handles are separated the points are pulled apart to enlarge the opening. Of this variety Smellie's scissors (see Fig. 1) may serve as a type. 4th, Better still are the Perforators that have the cutting edge of the blades turned outwards, and the blades not crossing at the joint, but hinged, so that when the handles are compressed the points of the blades are separated. Sir J. Y. Simpson's perforator (see Fig. 2) is the most widely employed instrument of this construction in this country, and Blot's in France. 5th, In Germany wide use has been made of Trephines, which are alleged to have the advantage of producing an opening with clean-cut edges, and so of diminishing the dangers that arise from the presence of protruding fragments and loose spiculæ of bone. 6th, The Basilyst possesses the advantages of both. If it be screwed into the vault as far as the shoulder and then withdrawn, a round aperture is left with smooth edges, through which the cranial contents may escape as after the use of a trephine. But in most instances a wider aperture is demanded, and this is produced with the basilyst when the handles are compressed and the points of the blades forced apart.

(2) *Preliminary Measures.*—Before proceeding to operate the practitioner has some points to consider: 1st, He will have the patient anæsthetised. 2nd, He will have the patient placed in the left lateral position with her knees bent up and her hips at the edge of the bed. It is sometimes more convenient to have the patient in the supine posture when she is asleep with chloroform. 3rd, Bowels and bladder must be empty. 4th, Provision should be made for receiving and covering up fragments of bone and the cranial contents. 5th, The operator must make one more careful examination to make out clearly the promontory of the sacrum, the margins of the os uteri, and the exact position of the head. 6th, An assistant keeps the head fixed at the brim by pressure from above through the abdominal walls.

(3) *Rules for Perforating.*—1st, The Perforator, held in the right hand, is guided to the head by the fingers of the left, which are touching the part selected for perforation. 2nd, The point of the instrument is directed against a bone. In a flat pelvis this will usually be a parietal bone. In the justo-minor it may be the occipital. In brow and face presentations the frontal bones will be struck. It is important to pierce a bone and not merely to go through a suture or fontanelle, else the edges of the bones may come together after the instrument is withdrawn, and little collapse of the skull be produced. 3rd, The perforator should be directed against the bone at a right angle to avoid the risk of its slipping on the surface. This rule is more needful to be observed with the older perforators than with the basilyst, the point of which, with its double-threaded screw, lays hold at once of the scalp and cannot slide off. 4th, Screw in the instrument up to the shoulder and open it widely and crucially. To obtain a wide gap in the vault it may be necessary to turn it in different directions and expand it. 5th, Advance the instrument into the brain and tear and break down as thoroughly as possible all the cerebrum, cerebellum, tentoria, and the ganglia at the base, otherwise the child may be extracted a living,

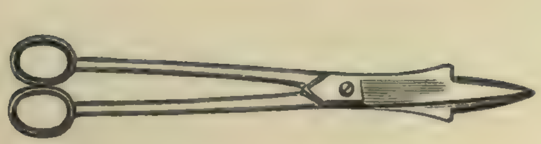

FIG. 1.—Smellie's Scissors for perforating the skull.

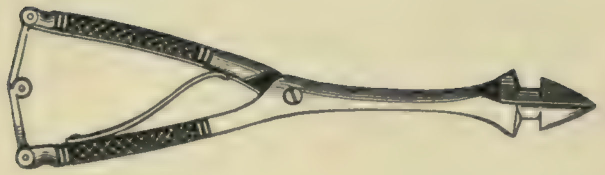

FIG. 2.—J. Y. Simpson's Perforator.

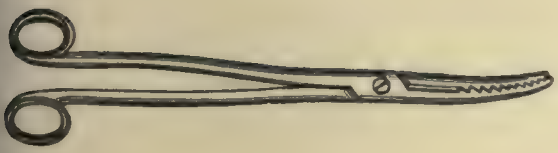

FIG. 3.—Lyon's craniotomy forceps.

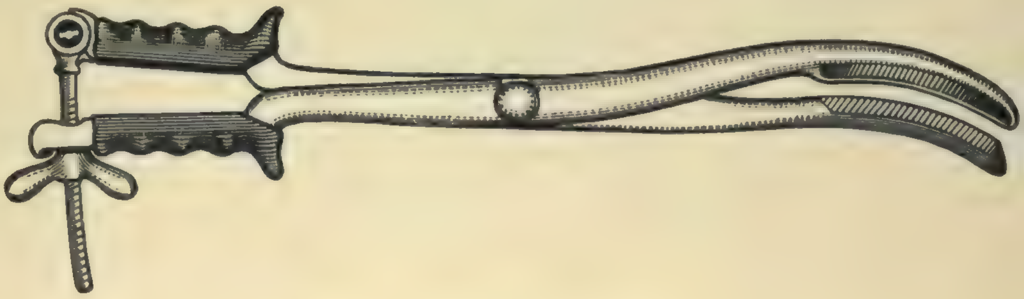

FIG. 4.—Carl Braun's cranioclast.

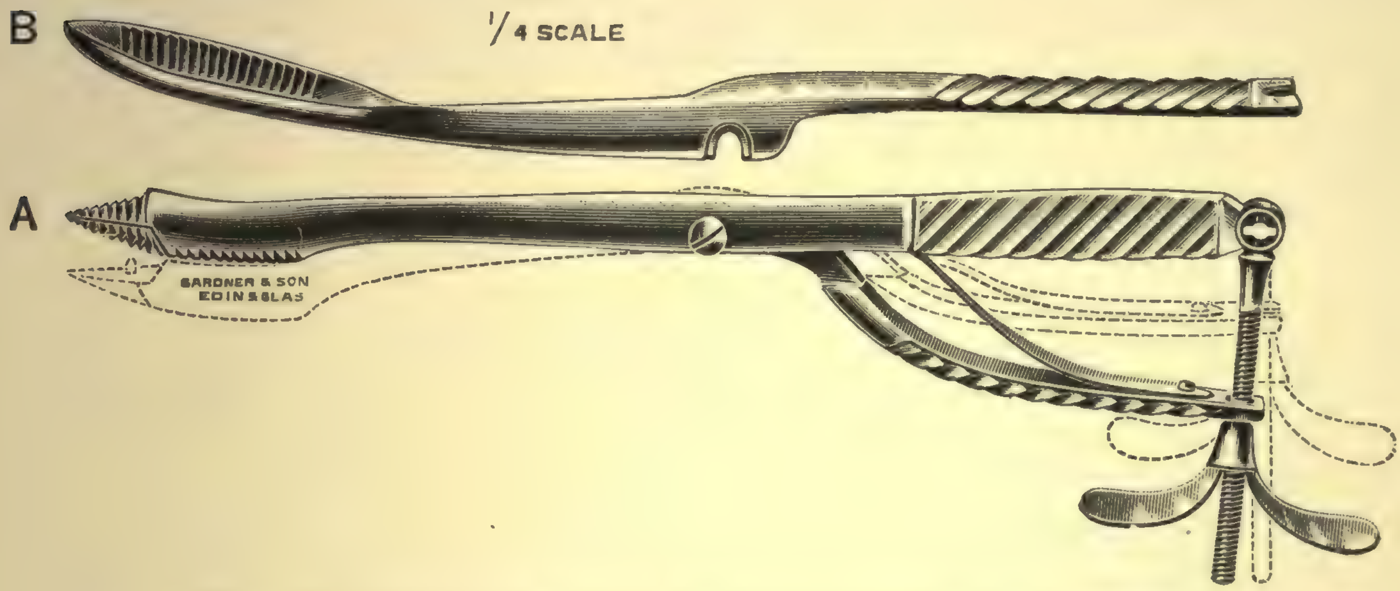

FIG. 5.—The basilyst. A, partially opened; B, the traction blade separated.

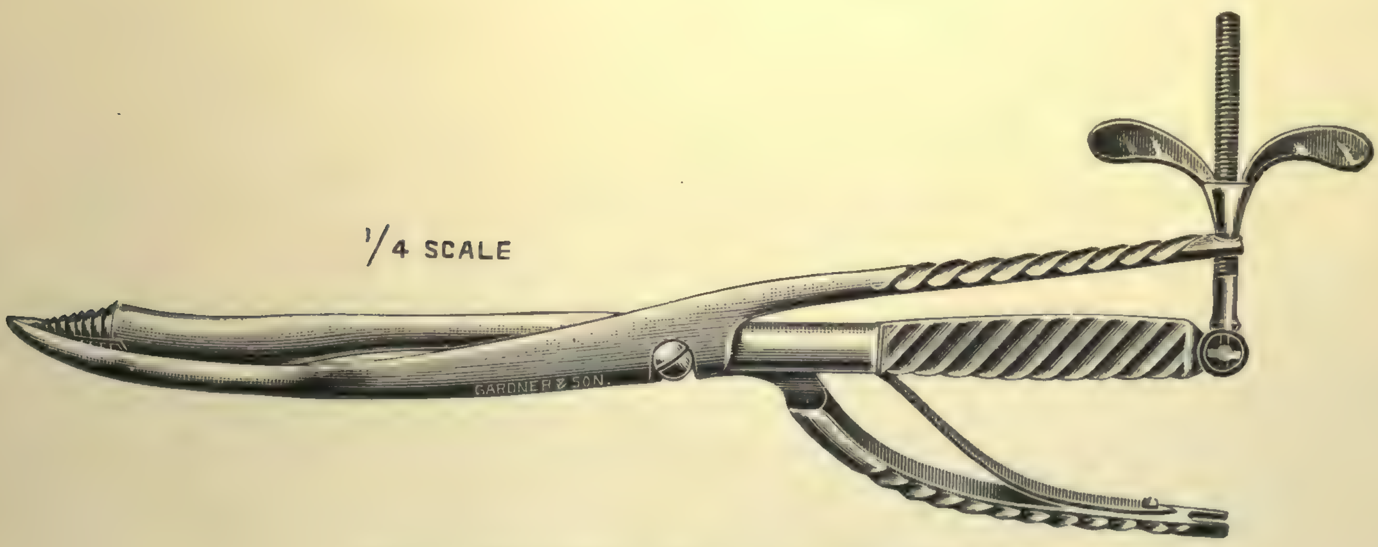

FIG. 6.—The basilyst with traction blade adapted.

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breathing horror. When quite dead a softening of its textures immediately ensues which facilitates its delivery. 6th, Wash out the cranial cavity and the maternal canals with an antiseptic lotion. 7th, Remove with the fingers or a pair of pincers any loose fragments of bone from the edges of the opening in the skull. In some cases the head may be found so diminished in bulk as to be capable of expulsion by the parturient powers, aided, perhaps, by traction from below with the finger of the practitioner passed through the opening, or by the pressure of the assistant's hands above. Usually, however, it becomes necessary to have recourse to further reduction of the size of the head.

II. *Head Comminution.*—Many methods have been adopted for breaking down the bones of the head, and many instruments have been contrived for the purpose. They may all be grouped in five categories.

(1) *Craniotomy.*—The earliest method consisted in laying hold of the plates of bone round the edges of the gap made in the vault and breaking off and removing the fragments morsel by morsel. The archaic writers on obstetrics describe pincers used for the purpose; and the Lyon's forceps and countless other modern varieties are only modifications of the ancient implements. At the best an operator can only succeed with them in picking away the bones of the roof and sides of the skull. After his most tedious efforts the bones at the base remain unbroken (see Fig. 3).

(2) *Cephalotripsy.*—It was an important advance that was made by Auguste Baudelocque when he contrived the cephalotribe. This is in essence a pair of powerful forceps provided with a screwing apparatus at the handles, by means of which the blades that embrace the head are brought together so closely as to crush and compress the whole skull. Variously modified, it was for many years the favourite implement all over the Continent for the head-reduction of the infant. But its use was attended with some serious drawbacks. The introduction of the thick blades into the cavity of the uterus carried with it the risk of the entrance of septic germs into the bruised maternal tissues. Whilst it effectually crushed the bones in flattening the head in one diameter, it lengthened it in another. It proved so unsatisfactory as an extractor that some obstetricians used it only to crush the head by repeated applications if need were, and left the expulsion to the natural efforts, or had recourse to turning.

(3) *Cephalotomy.*—The proposals to displace the cephalotribe by instruments that would cut the head in slices did not approve themselves to the general profession. The Labitom of von Ritgen was never used outside Giessen. The Saw-forceps of van Huevel made with a single chain-saw had for a time some vogue in Belgium, and stimulated Tarnier to construct and use one with a double chain that could cut the head into three sections. But they have both fallen into desuetude. The Wire-écraseur proposed for use by Robert Barnes is not easily applied.

(4) *Cranioclasm.*—In 1858 Sir J. Y. Simpson, examining the head of a child that he had extracted with unusual facility after fracturing the bones with a Murphy's craniotomy forceps, found that the occiput had been broken close to the foramen magnum. He recognised the necessity for facilitating the process in every case by fracturing the base of the skull, and contrived the Cranioclast for the purpose. Modified by Carl Braun von Fernwald, the cranioclast has almost everywhere superseded the cephalotribe (Fig. 4). In using it the solid blade is introduced into the opening made in the vault, the fenestrated blade is applied outside the head, preferably over the occiput, the point of it carried as far as possible to the neck of

the child. With a twisting movement the bones in the grasp of the blades are broken, and with the hold that has been obtained the operator makes an effort at extraction. If the head does not offer to descend easily he may relax the grasp and apply the outer blade to the side of the head or over the frontal bones, so as to fracture the skull more effectually.

(5) *Basilysis.*—When it is remembered that the firm, unyielding base of the skull is the greatest obstacle to the escape of the head, it becomes obvious that the ideal operation must be directed towards the breaking-up and loosening of the basic bones. With this view Fabbri of Bologna proposed the use of a pair of bone-pliers fashioned like a parrot's beak, which he described as a tenaglia, and which is intended to gouge out fragments of the sphenoid and neighbouring bones. Hubert of Louvain followed a procedure which he described at first as Sphenotresia and afterwards Transforation. It was effected by means of an instrument consisting of a long rod with a bulbous point that could be screwed through the vault and on into the base of the skull, and of a blade, resembling a solid lever, to be passed round the head. The blade and rod can be fixed close to their handles, and are so constructed that the point of the screw, when it has pierced the floor of the skull, is received into a depression close to the tip of the blade. The Basiotribe of Tarnier is of somewhat similar construction, but is provided with two blades, so that if the compression from one side prove insufficient, the second blade can be applied to crush the head from the opposite direction. The Basilyst, which we have seen to produce most satisfactorily the necessary aperture in the cranial vault, was contrived especially to be used for tearing up and dissolving the basis cranii. When the point has been screwed into any part of the base, and the handles compressed, the bones are not merely perforated, but torn apart. The perforation and dilaceration may be applied, if need be, to several of the bones—the ethmoid, the sphenoid, the petrous portion of the temporal or basilar portions of the occiput—and such a complete dissolution of the base effected as to allow of easy collapse and compression of all the skull. Further, crushing the head is brought about, when it becomes necessary, by applying the tractor blade for the purpose of immediate delivery. This fits to the perforating part of the instrument as the fenestrated blade of the cranioclast fits its solid blade, and gives to the basilyst all the additional value of the cranioclast as an extractor (see Figs. 5 and 6).

III. *Extraction.*—If the head is effectively comminuted the expulsion may be left for a time to the natural efforts. The soft parts between head and pelvis, being relieved of pressure, recover their circulation, and allow of the more easy transit. The uterus, after retracting, resumes its contractions more vigorously, and if it succeeds in expelling its contents, as it is now free to do, there is less risk of trouble in the third stage and subsequently.

In most instances the practitioner finds it desirable or necessary to proceed to the extraction of the mutilated infant. At one time hooks, blunt or sharp, single or double, were applied inside the skull or outside the scalp, to get purchase for traction. The hooking out of the fœtus is now almost obsolete. The cephalotribe, powerful as a crusher, fails as an extractor, for it is apt to slip, and it is difficult with it to adapt the head to the pelvic diameters. The cranioclast or the basilyst-tractor has the advantage of introducing only the one (fenestrated) blade into the cavity of the uterus, the other blade plays its part entirely within the cranium. They allow of the adaptation of the head to the configuration of the pelvis in all its planes, and in dragging on the occiput tend to elongate the head in sugar-loaf fashion. In extracting the operator (1) will see that he has taken a secure hold of the head, and it will be more satisfactorily done if the outer blade be placed over the hindhead. (2) He will see that the jagged edges of bone are covered with the scalp, keeping the fingers of his left hand in contact with the head whilst he pulls with the right hand. (3) He will make traction during the pains, and make sure that the uterus is following and aids in the progress of the fœtus. (4) He will pull in the proper axes of the different parturient planes. (5) He must be prepared in some cases to lessen the bulk of the trunk, as by cleidotomy. (6) He should in all cases make careful examination of the maternal canals after the labour is over to see if there be any spicula of bone left or any laceration that may need repair. It goes without saying that the whole procedure must be conducted on aseptic principles, and that after such an operation it will be desirable to wash out the uterine cavity with an antiseptic douche, or at least with hot sterilised water.

B. In Trunk Presentations

Indications.—There are a few cases of narrow pelvis where, after the head has been crushed, the thorax fails to enter the brim, and it becomes necessary to lessen the trunk also. But it is usually in cases of transverse presentation that the necessity arises for breaking up the trunk. A shoulder is presenting, possibly the arm has fallen to the vulva; the waters have all escaped; the uterus is closing firmly round the fœtus, which becomes impacted at the brim and cannot be driven through; the lower uterine segment, the cervix, and the vaginal roof are all becoming stretched and thinned, and in danger of rupture. The child is very likely already dead or dying, so that there is no hope of rescuing it by turning, which would now be dangerous to the mother. Her only chance lies in delivery by embryotomy.

Procedures.—There are different procedures that the practitioner may adopt in seeking to effect a diminution in the size of the passenger. Some have begun by removing the arm, cutting it off at the shoulder joint, or better, passing a finger or hook or forceps through the wound in the axilla and bringing away the scapula, and perhaps the clavicle, along with the prolapsed extremity. Such mutilation, however, is usually futile. It does not reduce the bulk sufficiently to make version safe or to allow of the expulsion of the infant; and the operator has deprived himself of the safest medium for traction on the trunk if he removes the arm and then finds that he has to eviscerate the cavities or break through the spinal column. Cleidotomy (division of the clavicle), which allows of some degree of collapse of the upper part of the trunk, and may facilitate extraction through a pelvis that has required head comminution, is of little or no avail in transverse presentations.

I. *Evisceration.*—Delivery has often been effected by opening the thorax and abdomen with some variety of perforator and disembowelling the fœtus with the forceps or fingers. This Evisceration or Exenteration, as it has sometimes been called, does not usually secure sufficient diminution of the bulk of the infant to allow of its extraction. It only lessens the soft structures and leaves untouched the spinal column, the resistance of which constitutes the great difficulty to the passage of the trunk.

II. *Decapitation.*—If the spinal column can be severed in the cervical region by Decapitation of the fœtus the difficulty is overcome. Different methods have been adopted for separating the head from the trunk. (1)

The neck has been divided from below upwards with knives or scissors, a method dangerous both to the maternal tissues and the fingers of the operator. (2) Ramsbotham's sharp hook carried round the neck was at one time the approved implement for cutting through from above. But its cutting edge on the concavity of the hook was also not free from danger to mother or operator. (3) The chain or wire of an écraseur has been used, but the obstetrician may have difficulty in getting the chain or the wire adapted to the neck. (4) Pajot had a special hook constructed for carrying a loop of whip-cord or strong twine round the neck. A stout copper wire bent double can be curved so as to go round the neck, and as it is withdrawn it can carry back the cord which is to be used for sawing through the neck. (5) Braun's decapitator, which is a long blunt hook like a boot-hook, is the simplest and safest of all the decapitating implements. The curve of the hook is small, so that it is relatively easy of application; a half twist usually suffices to break the vertebral column, and an additional twist or two tears through the soft parts as well.

Delivery by this method implies, first, the Decapitation itself; second, Extraction of the Trunk (this will usually be brought about by pulling on the protruded arm); third, Birth of the detached Head. This may be effected by pressing upon the uterus from above, but sometimes the head requires to be laid hold of with forceps, or some kind of hook, or to be perforated and extracted with a cranioclast or basilyst.

III. *Spondylotomy or Spondylolysis.*—In some cases the neck is not accessible. The trunk of the fœtus has got jammed into the pelvis with the head above the brim, so that decapitation is impossible. In such cases Sir J. Y. Simpson proposed the use of the Spondylotome for cutting through the spinal column in its most accessible part, usually in the dorsal region. The spondylotome is a pair of strong scissors, one blade of which is sharp-pointed for perforating the thorax, whilst the other probe-pointed blade is passed outside over the vertebral column, so as to cut through the spine. A pair of bone-pliers may be used for the purpose. When the vertebral column has been thus divided the trunk can be doubled together, and may be expelled by the natural efforts aided by pressure from above or traction from below with a hook or cranioclast. On the dead fœtus in a phantom it has been found that the basilyst can be made to perforate and tear up the spinal column even more thoroughly than the cutting instruments, and its use as a Spondylolyst is attended with this advantage, that after the vertebræ have been broken the tractor-blade can be at once applied outside the trunk so as to facilitate the extraction of the infant.

6. Symphysiotomy

An extremely clear and judicious estimate of the relative position of this to other obstetric operations has recently been given by Professor Bar in his *Leçons de pathologie obstetricale.* Combining his own results in 23 cases with those of Pinard, Zweifel, and Küstner, he finds that the present maternal mortality in symphysiotomy is 7·45 per cent, and the infantile mortality 9·3 per cent.

INDICATIONS.—Symphysiotomy came on the field in the interests of the mothers whose lives were sacrificed in Cæsarean operations, and whilst it is still chosen in certain cases as a safe alternative to these procedures, its employment is more urgently advocated in the interests of the infants whose lives are sacrificed in embryotomy operations. It is intended to widen the canals with less danger to the mother than was implied in opening the peritoneal cavity and the uterus, and it allows of the passage of the undiminished head of the infant in cases of pelvic contraction. The form of pelvic contraction to which it is best adapted is the pelvis *æquabiliter justo minor*, but it is had recourse to also in the rickety and osteo-malacic pelves. In the Naegele pelvis, as Farabœuf has shown, section of the symphysis should be avoided, and, instead, the innominate bone on the side of the synostotic sacro-iliac joint should be sawn through the ischio-pubic rami, so as to allow of expansion of the bony girdle at the double hinge of the symphysis pubis and of the healthy sacro-iliac joint. Symphysiotomy has been performed in women with pelves measuring as much as 9 cm. ($3\frac{3}{4}$ ins.) in the conjugate of the brim; but we expect in pelves with this space to witness the birth of the child under the natural efforts or with the aid of forceps or turning. On the other hand, where the conjugate is reduced to $2\frac{1}{2}$ ins. (6·3 cm.), it is hardly possible that sufficient expansion would occur for the extraction of a living child, unless, according to the suggestion of Novi, symphysiotomy be conjoined with induction of premature labour. Morisani's minimum contraction of the conjugate of 6·7 centimetres ($2\frac{5}{8}$ ins.) should be maintained as the utmost limit in this direction for symphysiotomy interference, and 9 centimetres ($3\frac{1}{2}$ ins.) in the other, and the operation should, as a rule, be reserved for multiparous women, in whom the dilatation which the soft parts have undergone during their previous labours will lessen the dangers both to mother and child. The operator must, of course, make sure that the infant is alive and vigorous.

Methods of Operating.—Consideration has to be given to:—

I. *The First Stage of the Labour.*—In some cases the labour is already so far advanced that the more strictly surgical interference is at once demanded. In these patients too often there have been preliminary attempts at delivery with forceps or by turning, that may have seriously impaired the prognosis for mother and child.

With a pelvis at the higher limit of contraction—say from 8 to 9 cm. (3 to $3\frac{1}{2}$ ins.) it may be permissible to make cautious use of these alternative operations in cases where yet the operator fears he may have to divide the symphysis; but where the contraction approaches the lower limit such interference would be futile and dangerous. Only in some cases of multiparous women, where the operator has made up his mind eventually to deliver by turning and extraction on the limbs, he may bring about the preliminary version by external manipulation, or by the bi-polar method whilst the membranes are still unbroken, so as to facilitate the seizure of the leg when the moment for extraction shall have come. It is to be remembered that in women with contracted pelves the first stage of labour is apt to be prolonged, and it may sometimes be of advantage to promote the dilatation of the cervix and of the vagina by means of douches and hydrostatic dilators. The operator has to take note further of any complication that may be present, such as prolapsus funis, and prepares to intervene only when the first stage is completed and the cervical canal is fully dilated.

II. *The Division of the Symphysis.*—It goes without saying, that as all obstetric procedures should be carried out under as aseptic conditions as possible, so especially in this surgical intervention operators are careful to have the whole lower abdominal and pudendal region shaved and cleansed, and the parts and passages disinfected. Three different methods have been adopted in cutting through the symphysis:—

1. *The Neapolitan Method.*—Morisani and his school usually make an incision of $1\frac{1}{2}$ ins. to 2 ins. in length through the skin and subcutaneous structures in the hypogastrium and mons veneris. The lower extremity of the incision terminates just above the upper margin of the symphysis pubis, and the deep part is widened by dissecting some of the muscular fibres from the pubic bone. An assistant pulls the urethra and bladder backwards with a metallic catheter, and the operator, pushing his finger down behind the symphysis, detaches the loose

retro-pubic connective tissue, and guides a Galbiati knife down below the lower margin of the symphysis. With this knife, probe-pointed and sickle-shaped, with the cutting edge in its concavity, he divides the interosseous cartilage and ligaments from below upwards and from behind forwards, until a creaking sensation tells him the section is complete, and he feels the bodies of the pubic bones spring apart. This symphysiotomy is thus almost a subcutaneous operation.

2. *The Parisian Method.*—M. Pinard and his confreres divide the structures of the mons veneris in front of the symphysis in their entire length from above the pelvic brim to below the anterior commissure of the vulva, close to the clitoris, by an incision from three to 4 inches in length. When the pubic joint is exposed the recti in the upper part of the wound are separated to allow of the entrance of the finger into the pre-vesical cavity. This guides the bistoury which cuts through the symphysis from above downwards and before backwards.

3. *The Leipzig Method.*—Professor Zweifel makes a transverse incision through the structures in front of the symphysis, a finger's breadth or a little more below its upper margin. The fascia over the joint and for some distance above towards the umbilicus is laid bare, and the lips of the wound pushed up and down with the finger-nail till the lower margin of the sub-pubic ligament is exposed. The fascia between the recti is now divided, and a finger being pushed down into the retro-pubic space, the cartilage is cut through with a probe-pointed knife from above and in front downwards and backwards.

Some operators have had difficulty in hitting on the joint tissues, and have had recourse to the use of a saw or chisel to divide the osseous structures. This adds greatly to the dangers of the operation, and where patients survive the convalescence is prolonged and perhaps imperfect. Dr. Sandstein, in his graduation thesis, points out that in 50 per cent only is the symphysis median ; in $33\frac{1}{3}$ per cent it is to the left, and in $16\frac{2}{3}$ per cent to the right of the middle line, and that, further, it frequently slopes towards one side instead of being vertical. He finds a guide to its upper margin in a projection that can always be felt between the pubic bones at their upper margin, and that is continued as a ridge on the posterior aspect of the symphysis. When the symphysial tissues are severed, the bodies of the pubic bones spring apart spontaneously to a distance of 2 to 4 cm. ($\frac{3}{4}$ in. to $1\frac{1}{2}$ ins.) If the patient is in the Walcher position, with the legs hanging down over the end of the table, the separation is greater. Zweifel avails himself of this tendency of the dependency of the limbs to strain the symphysial structures at their upper margin to facilitate their section. Where a greater separation of the bones is demanded pressure is made on the inside of the limbs flexed upwards on the abdomen. They have sometimes been separated as much as 7·5 cm. (3 ins.) ; but a separation of from 5 to 6 cm. (2 ins. to $2\frac{3}{8}$ ins.), or fully two fingers' breadth, gives the full advantage of the expansion without endangering the sacro-iliac ligaments. That one side of the pelvis is moving more than the other can be recognised, according to Sandstein, by noting that the upper margin of the less mobile innominate remains at a higher level, and then it becomes necessary to make pressure on the inner side of the corresponding thigh, to stretch the sacro-iliac joint, and to prevent the sacro-iliac ligaments of the mobile side from being unduly strained and torn. Sometimes there is free bleeding from the incised soft parts that has to be checked with pressure forceps, or by the pressure of the fingers of the assistants who are controlling on the two sides the movements of the limbs. The wound is packed with iodoform gauze, or otherwise kept from the chance of any germ-invasion, whilst attention is given to—

III. *The Birth of the Child.*—The dilatation of the pelvis may be sufficient to allow of the expulsion of the infant by the natural powers. During the transit of the head the pubic bones may be further separated and a fresh access of hæmorrhage set up. Hence it is necessary to have an intelligent assistant at each side who will keep up such pressure on the trochanters as will prevent undue and dangerous distension. Where the parturient powers are insufficient for the expulsion, the operator must have recourse to the extraction of the infant, either by means of version and traction on its leg, or by application of forceps to its head, according to the conditions that emerge in each individual case. Whether the child be born naturally or extracted artificially, it has to be borne in mind that the anterior vaginal wall and the soft parts in relation with it are deprived of their usual bony protection, and may easily be stretched and torn to a degree that will endanger the patient's life or render her recovery imperfect. After the birth of the infant the obstetrician sees to the complete evacuation of the uterus and its usual post-partum contraction before he turns again to complete the surgical intervention necessary to secure the union of the severed surfaces.

IV. *Closure of the Wound.*—The Neapolitan procedure at this stage simply requires the careful suturing of the supra-pubic incision, and the keeping together of the bodies of the pubic bones so as to secure the reunion of the symphysis by means of carefully adjusted bandages. Operators who have laid bare the pubic bones before dividing the symphysis have in some instances drilled the bones so as to allow of their being kept together by a couple of metallic sutures. For the most part it has been found sufficient to pass silk sutures through the aponeurotic tissues, and after the soft parts of the wound have been duly sutured to apply a bandage or keep the pelvis immobile in a hammock or in a special framework. Care must be observed in bringing together the separated bones that none of the soft parts that lie behind get caught between them, else damage may ensue to the bladder or urethra.

RESULTS.—In 1892 Spinelli gave a résumé of twenty-four cases of symphysiotomy that had been carried out by Morisani and his colleagues in Naples during the preceding fifteen years, which showed that all the mothers had recovered, and only one child had been lost. In four of the instances the operation was performed twice in the same patient. One woman had her second symphysiotomy fourteen months after her first. Another, who had been able to be out of bed by the eighth day, was operated on seventeen months later, and got up after the second symphysiotomy on the seventh day. These results, and the statistics of maternal and infantile mortality already quoted from Bar, give, however, an unduly favourable impression of the life-chances attendant on this mode of delivery. The danger to the life of the mother arises mainly from the double possibility of septic absorption through the long-exposed pubic wound, and through the bruised and fissured parts of the genital canal, but also from the hæmorrhages, primary or secondary, from the wound or from the uterus. It has to be kept in view, moreover, that there may be protracted convalescence because of inflammations set up at the damaged joints, pubic or sacro-iliac, or among the areolar tissues of the pelvis, or in the bladder and urethra. Whilst, as a rule, the patient makes a complete recovery, she sometimes suffers afterwards from impaired power of progression when the reunion of the joint-ligaments has not been complete, from loss of retentive power in the bladder, or from prolapsus uteri.

7. Cæsarean Section and its Modifications

Cæsarean section is an operation whereby an opening is made in the abdominal wall, and another in the uterus, through which the fœtus is extracted.

According to Pliny, it is named Cæsarean because the first of the Cæsars was so extracted from his mother's womb as she was dying. According to another version, it is named from the operation itself, *cæso matris utero.*

This operation was at first made upon dead women at a more or less advanced state of pregnancy. It is attributed to Numa Pompilius, one of the first kings of Rome, who enacted (*lex regia*) that a pregnant woman deceased could not be interred until the fœtus was extracted. This law remained in operation throughout all countries under Roman rule, and was approved by the Church, as well as adopted as a civil law by northern states, more especially Germany. For many years they dared not perform the operation upon a living woman, and in this way encouraged the performance of craniotomy, as the passage of the fœtus through the pelvis in cases of deformity was impossible without mutilation.

Levret and Mauriceau deny that this operation was known to the ancients, but Dionis and Gardien refer to Pliny's *Natural History.* Dr. Mansfield published a work "On the Antiquity of Gastrotomy and Hysterotomy on the Living" (*Weber, das Alter des Bauch- und Gebärmutterschnitts am Lebenden zu Braunschweig,* 1824).

He states that in an earlier work named *Mischnajoth,* written about 1400, there is this passage, "In a twin birth, neither the first child which by section of the belly is brought into the world, nor the one coming after, can attain the rights of heirship or priestly office."

Nicolai Falconiis recorded a case at Venice in 1491. The case of Jacob Niefer, the Swiss peasant who performed it upon his own wife, is frequently quoted, but most authorities are agreed that it was much later before it was generally attempted upon the living woman. In fact, we need only refer to the action of Mauriceau in the case treated by himself and Chamberlen, where the operation was delayed till after death, although Mauriceau was in actual attendance for several days. He wrote: "The child has been dead to all appearance about four days, and I told all the assistants that she could not be delivered. They asked me to perform Cæsarean section, which I did not wish to do, knowing that it was always certain death to the mother." This poor woman died with her infant in utero twenty-four hours afterwards.

Rousset, physician to Catherine de Medicis, and contemporary of Paré, published a work upon the subject in 1581. This book was translated into Latin about ten years later. The author attempted to prove the possibility of saving the mother and child by means of this operation, but his views were opposed by Paré, Guillemeau, and others. In the middle of last century the subject divided operators into two sections, the Symphyseans and Cæsareans, or those who advocated division of the symphysis pubis and those who advocated Cæsarean section.

It may be taken as a recognised rule in midwifery that no woman should be allowed to die undelivered without some attempt being made to save her and her offspring, or at least to save her at the expense of her child.

Concerning the latter point, whether we are justified in destroying the infant when alive, there has been, and still exists, difference of opinion, due in some measure to religious belief, and likewise to the personal feeling of the husband, who felt that very little hope was held out to him that his wife could be saved by section. Amongst such men we had Napoleon, who, when appealed to by Dubois, said: "Treat the Empress as you would a shopkeeper's wife in the Rue St. Martin, but, if one life must be lost, by all means save the mother." In marked contrast to him we had Henry VIII., who, when thus questioned before the birth of his son Edward, exclaimed: "Save the child by all means, for other wives can be easily found." At the present time such men might be put down as either a good husband but a bad father, or a good father but a bad husband.

The doctrine of the Roman Catholic Church has been that, if you could not extract the child without killing it, you could not, without mortal sin, do so, and likewise until lately, it was held that the infant could not be baptised in the uterus, as it should be *natus* before it could be *renatus* by baptism.

Of late years the happy results following Cæsarean section and Porro's operation have done much to efface the dreadful feeling that we have got in such cases to decide whether the life of the mother or that of the child is to have our preference, seeing it is now quite possible to save both.

Barnes wrote: "Cæsarean section is resorted to with a feeling akin to despair. Embryotomy stands first, and must be adopted in every case where it can be carried out without injuring the mother. Cæsarean section comes last, and must be resorted to in those cases where embryotomy is either impracticable, or cannot be carried out without injuring the mother. There is, therefore, no election. The law is defined and clear. Cæsarean section is the last refuge of stern necessity."

As against this statement, Dr. Barnes has recently said: "It is no longer permitted to us, without ample proof of clear necessity, to sacrifice the child in order to save the mother. The cases in which the two lives are supposed to stand in antagonism are vanishing before the light of modern science and skill."

If anything is needed to sicken one at the revolting practice of craniotomy, I might be allowed to relate the obstetric history of a rachitic woman, who during her three last confinements was under my personal care:—

1st—1862, . .	Embryotomy.
2nd—1863, . .	Embryotomy (labour induced).
3rd—1864, . .	Embryotomy.
4th—1865, . .	Induced labour at half term.
5th— — , . .	Embryotomy (Birmingham, L.I. Hosp.).
6th—1868, . .	Induced labour at half term.
7th—1870, . .	Embryotomy.
8th—1871, . .	Embryotomy (eighth month).
9th—1873, . .	Embryotomy.
10th—1874, . .	Embryotomy.
11th—1875, . .	Induced labour at half term.

We must never forget that we have a sacred trust, and I hold we have no right to sacrifice a child, however unequal its life may be in some cases, to that of the mother. In advocating the preference of section as against craniotomy in the living child, I do so only after very mature consideration, and with a feeling that to do otherwise would be to sacrifice a life which I was bound to preserve. I think the time has come when the lives of the mother and child may alike be saved, and prefer to think that an infant come to maturity is destined for something greater than to have its glimmering life extinguished by an accoucheur skilled in the use of a dreadful perforator. Let our motto be, "We live to save and not to destroy."

In another case where the obstetric history was like the preceding one, Cæsarean section was performed, and the mother now attained her long wished-for desire, a living child.

Burns in twenty-four cases gave twenty-two deaths, whilst others gave the death-rate as from 50 per cent to 100 per cent.

With such results it is not to be wondered at that so many opposed the operation. In England, for example, accoucheurs condemned it absolutely. In Paris, during half a century, there was not a successful case, although it had been performed about sixty times. In the large Maternity Hospitals of Paris and Vienna, with from four to eight thousand confinements in the year, not a single successful case of Cæsarean section has been recorded. No doubt now exists that the great fatality was due to the fact that the operation was only resorted to after other measures had failed.

Indications for the Operation.—As regards the general indications for the operation, of course they vary in the hands of different operators, as some, still looking upon Cæsarean section as a last resource, divide the indications into absolute and relative. The absolute is where the deformity of the pelvis is so pronounced that the passage of even a mutilated fœtus is impossible, whilst the relative is where they may remove a mutilated fœtus by the natural passage with as good or a better result for the mother. It is here that difference of opinion exists. Baudelocque admitted Cæsarean section in cases with a conjugate diameter under two and a half inches; Cazeaux two inches; Tarnier two inches, and Depaul from one and a half to two and a quarter inches where the child was alive, and under one and a half inch when the fœtus was dead. Stolz advocated Cæsarean section whenever the child was alive and could not be brought through the natural passage.

Scanzoni	under three inches.
Naegele and Spiegelberg . . .	„ two „
Barnes, Playfair, and Leishman . .	„ one and a half inch.

Of late years the good results following Cæsarean section in the hands of Cameron, Leopold, Sänger, and other operators has materially changed the views of many authors, who now favour Cæsarean section more than they have done in the past.

Lusk, at the International Congress held at Washington in 1887, declared that Cæsarean section was preferable to embryotomy even with a conjugate diameter from two and a half to three inches when the child was alive.

It can well be urged that:—

(1) Embryotomy in a very contracted pelvis is as dangerous to the mother as Cæsarean section.

(2) Embryotomy always compromises the life of the child, whilst Cæsarean section gives a living child.

(3) No one has any right to sacrifice a child where he can save it, without exposing the mother to any additional risk.

For these reasons the operation should be one of election when the child is alive, and it should be performed before the patient is exhausted—in fact, early after labour has commenced, or even at full term before labour sets in, especially in multiparæ. In all cases it should be done before rupture of the membranes, and if possible the patient should be placed under the care of an experienced operator.

Little difficulty is experienced in obtaining the consent of the patient and her friends, and it is better to have her under observation previous to the operation, so as to regulate her diet, and have her prepared for operation beforehand.

A very important point in favour of Cæsarean section is that the Fallopian tubes can be tied and divided, so as to prevent subsequent conception, whereas embryotomy may require to be performed ten or a dozen times.

Besides deformity of the pelvis, other conditions, such as tumours or cancer of the cervix uteri, may exist which would demand either Cæsarean section or some modification of it.

If the child be dead and the conjugate diameter not over an inch and a half, Cæsarean section should be done.

Rousset, the earliest writer upon this subject, recognised the indications, the one furnished by the fœtus, and the other by the mother. Under the first category he placed excessive size of the fœtus, monstrosities, and faulty positions. Under the second he placed marked contractions from whatever cause. Some operators would include placenta prævia and puerperal convulsions. Cæsarean section might be advisable in some cases of eclampsia, but a skilful obstetrician would never think of such procedure in the case of placenta prævia. In fact, the operators who advocate this step are surgeons who have little or no experience in obstetric practice.

Our decision for operation should be based upon the degree of contraction of the pelvis, the size of the child's head, and its reducibility, unless the obstruction is due to some other cause, such as cancer or the presence of a tumour in the pelvic cavity.

Every practitioner should be able to form a fair estimate of the amount of contraction, as it is easier to measure a contracted pelvis than a normal one, and it does not require a highly skilled obstetrician to say before labour has commenced, or during the early stage of the process, that the diameter of the pelvis is, or is not less than three inches, and as a matter of fact, such a pronouncement should be within the skill of the ordinary practitioner, who should be more than a generally useful person, otherwise he will sink to the level of an ignorant midwife. Not only must he be able to form an estimate of the amount of contraction, but, by patient study of normal cases, qualify himself to form an opinion as to whether it will be impossible for a living child to pass, and also whether, under the difficult circumstances in which he may be placed, it would not be better to send the patient where Cæsarean section could be safely performed than to extract a mutilated fœtus through a minimum diameter.

With a diameter under two and a half inches, where engagement of the head is impossible, no one should hesitate to advise Cæsarean section, although there will always remain cases, such as where the child is dead or a subject of hydrocephalus, in which craniotomy may be resorted to.

Experience alone will enable one to avoid extreme measures in cases with a conjugate diameter measuring more than three inches, and where the skilled practitioner will weigh the chances between premature induction of labour and symphysiotomy.

There can be no questioning that Cæsarean section is a highly dangerous operation, but the danger, it should be remembered, depends for the most part on delay, and death most frequently results not so much from the operation, as from previous operative abuse, which is the just term for all injudicious attempts to extract the fœtus through a deformed natural passage.

Success depends upon prompt interference before the patient is exhausted, as then there is less danger from hæmorrhage, delayed shock, or peritonitis.

When Cæsarean section has been resolved upon, another question presents itself, namely, whether Cæsarean section or Porro's operation is preferable. If the former, there still remains to be decided whether the operation will be accompanied or followed by a removal of the ovaries, or the patient be sterilised by the simple expedient of tying and dividing the Fallopian tubes. This we have done in about fifty cases, and no harm has resulted, although theorists would have us believe that such a procedure would be surely followed by hæmatocele. Where there is a choice of operation Cæsarean section is to be preferred, as it can be completed much sooner, and is free from the danger of shock and peritonitis which might complicate Porro's operation.

The preparation of the patient will depend upon the urgency of the case. When she is under observation it is better to confine her to bed for a couple of days beforehand, and the bowels should be moved by an enema and a slight laxative. The abdomen is washed and gently scrubbed, and the parts shaved, whilst the vagina is cleaned and rendered aseptic. The preparation, in fact, is the same as in any other abdominal section. The operator and his assistants who have to do with the case must be exceptionally careful in cleansing and disinfecting their hands, whilst the chief nurse should see that the instruments and sponges are sterilised and counted.

Very few instruments are necessary, and should comprise two straight scalpels and one blunt-pointed bistoury, pressure forceps, dissecting forceps, scissors, director, twenty straight two and a half inch Hagedorn needles, compression pessary, aseptic silk, silk-worm gut, adhesive plaster, and dressings.

The catheter should always be passed into the bladder shortly before operation. The needles should be threaded in pairs beforehand, with No. 3 Chinese twist silk ligatures, about twenty inches long, and placed in a towel wrung out of 1-30 carbolic solution, ready for use.

Palpation will reveal the position of the fœtus, and this is all the more important, as from this you will know the attachment or site of the placenta.

Briefly, my experience in Cæsarean section has shown me that in dorso-posterior positions the placenta is attached upon the anterior wall, whilst in dorso-anterior positions the placenta is upon the posterior wall.

(*a*) Thus, in the first cranial position, or O. L. A., the placenta will be found upon the posterior wall, and somewhat to the right side.

(*b*) In the second cranial position, or O. D. A., the placenta will be upon the posterior wall, and somewhat to the left side.

(*c*) In the third cranial position, or O. D. P., the placenta will be upon the anterior wall, and somewhat to the left side.

(*d*) In the fourth cranial position, or O. L. P., the placenta will be upon the anterior wall, and somewhat to the right side.

The fœtus and placenta will be found in the same relation in the various pelvic positions.

From this knowledge you know when your uterine incision is likely to cut down upon the placenta, and you also form an idea as to how you will extract the fœtus. The abdominal incision should be made in the median line, as in ovariotomy, and it will vary in situation according to the distension of the abdominal wall.

Thus, if the abdomen takes the form as seen in Fig. 1, an incision of from five to six inches may be got without extending beyond the umbilicus, but when it is pendulous as in Fig. 2, the incision must of necessity extend more or less above the umbilicus.

Before opening the uterus the operator should satisfy himself that the uterus is not only in the median line, but that it is not twisted upon its axis. This is found by locating the position of the Fallopian tubes by means of the fingers. He will frequently find the left tube more or less in front, as the uterus is usually rotated to the right. This displacement must be corrected, and if necessary an assistant can easily keep the uterus in position by pressing with his hand on the right side.

When the placenta has its attachment upon the anterior wall the site is seen to bulge, and upon palpation has a fluctuant feeling akin to a large pointing abscess.

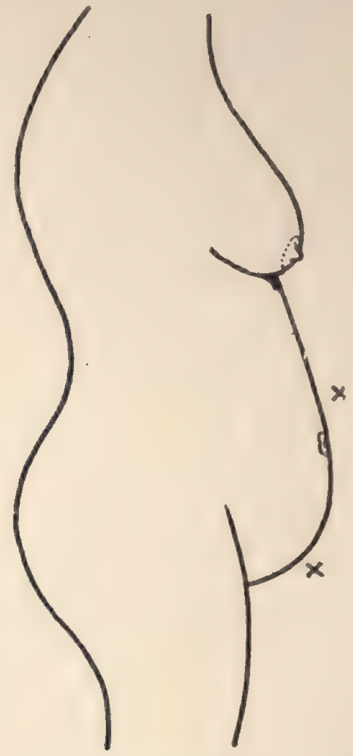


FIG. 1.

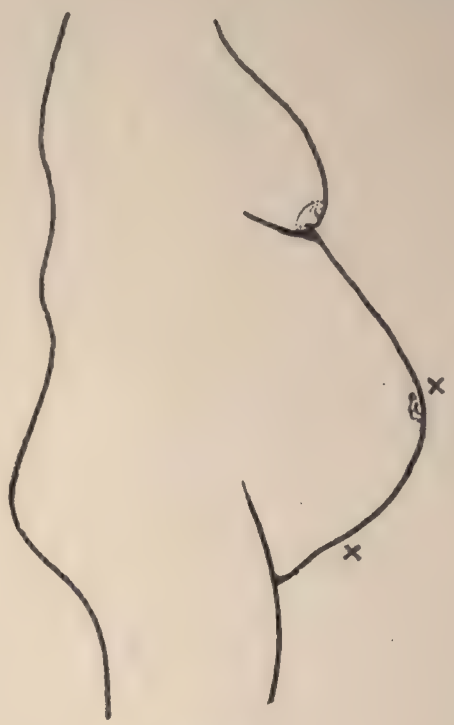


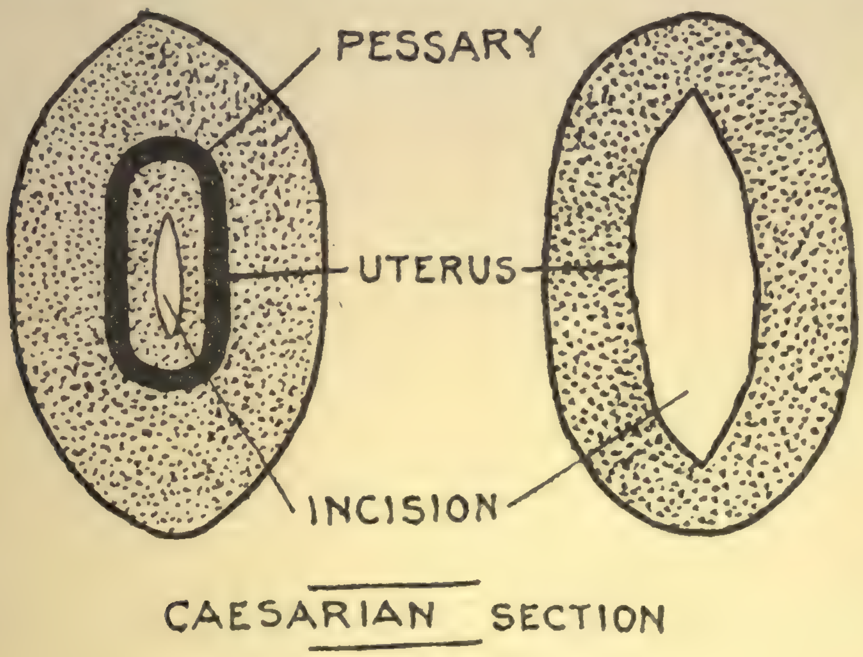
FIG. 2.

The next point is to open the uterus with as little loss of blood as possible, and this can be done by placing a flat vulcanite pessary upon the uterine wall around the point to be incised, as in Fig. 3.

The operator with the fingers of his left hand applies pressure upon the pessary, whilst his assistant does the same on the opposite side. The incision is then made with two or three strokes of the scalpel, and the blood sponged away by the assistant with his right hand. After this has been done no more bleeding takes place unless the placenta is attached in front, as the pressure with the pessary thoroughly prevents even oozing. Care should be taken not to puncture the membranes, which will soon be observed and recognised by their pearly colour. If the placenta intervenes this method of pressure is beneficial not only in preventing bleeding, but also in permitting us to observe its tissue, which is recognised by its darker colour.

Whenever the membranes are reached a director is placed within the opening, which is then enlarged with a blunt pointed bistoury, upwards and downwards as far as the pessary will admit. At this stage the compression pessary is removed, and the incision extended upwards and downwards sufficiently to permit the passage of the fœtus. The extension of the incision downwards should be limited, as it is likely to interfere with proper contraction of the uterus. Should the placenta intervene, it must be dealt with as a placenta prævia after completing the incision, that is, either separated upon one side or, if central, pierced by the hand. There must be no hesitation in extending the incision, which is made upwards and downwards from within outwards in each direction with a blunt pointed bistoury, so as to make an incision of about five or six inches, as in Fig. 4. The left hand is inserted without rupturing the membranes till the head is being turned out, or the feet grasped, and then the child should be extracted without delay. On no account should the hand be withdrawn after its insertion, unless during extraction of the fœtus, as the uterus speedily contracts. If the shoulder presents, a hand should be placed upon it to prevent its expulsion, as it adds very much to the difficulty when any portion of the child's body is allowed to protrude.

The child having been extracted, the assistant places a large flat sponge over the upper angle of the abdominal incision, to prevent the bowels from escaping, and then with both hands grasps the uterus, so as to prevent bleeding.



Figs. 3, 4.

The cord having been tied and divided, the placenta is immediately removed with the left hand, great care being taken to secure the removal of all membranes and to prevent the entrance of blood into the peritoneal cavity. The assistant now everts the uterus from the cavity, and pushes a flat sponge behind it. The lips of the uterine wound are next everted, the assistant grasping the upper angle and wall with his right hand, and the lower angle and wall with the left, as in Fig. 5.

The operator immediately inserts the silk ligatures, beginning at the middle, each suture grasping the entire wall, with the exception of the mucosa. From seven to ten sutures should suffice, as with the contraction of the uterus the incision is greatly diminished.

This accomplished, the sutures are gathered up and a large flat sponge laid over the anterior wall, and another behind. Firm compression or kneading is then made through the sponges, with the result that the uterus contracts firmly. The assistant should again seize the uterus as before, whilst the operator ties the sutures. When this has been accomplished the whole organ is enveloped in a large, warm, flat sponge, and firm compression again made so as to insure thorough contraction. Should any oozing appear at the needle punctures, a second warm sponge should be applied, and very slight compression will suffice to overcome any tendency to relaxation. Should the peritoneal edges gape at any points, a few superficial fine sutures should be inserted to bring the margins together.

The performance of hysterectomy for bleeding is bad treatment, and indicates that the operator has lost his nerve, as pressure with a warm sponge with both hands never fails to secure thorough contraction.

Several operators advise the introduction of a drainage tube through the cervix and vagina, and the leaving it there to act as a drain. Nothing could be worse. Of course, it is the procedure of a surgeon, but every one who has practised midwifery knows that the presence even of a clot in the uterus may lead to serious hæmorrhage. Such a body as a tube, if not expelled, would induce hæmorrhage, distension of the uterus, and bursting of the incision, with speedy death of the patient. This is no mere theory, but is what has actually taken place where drainage has been resorted to.

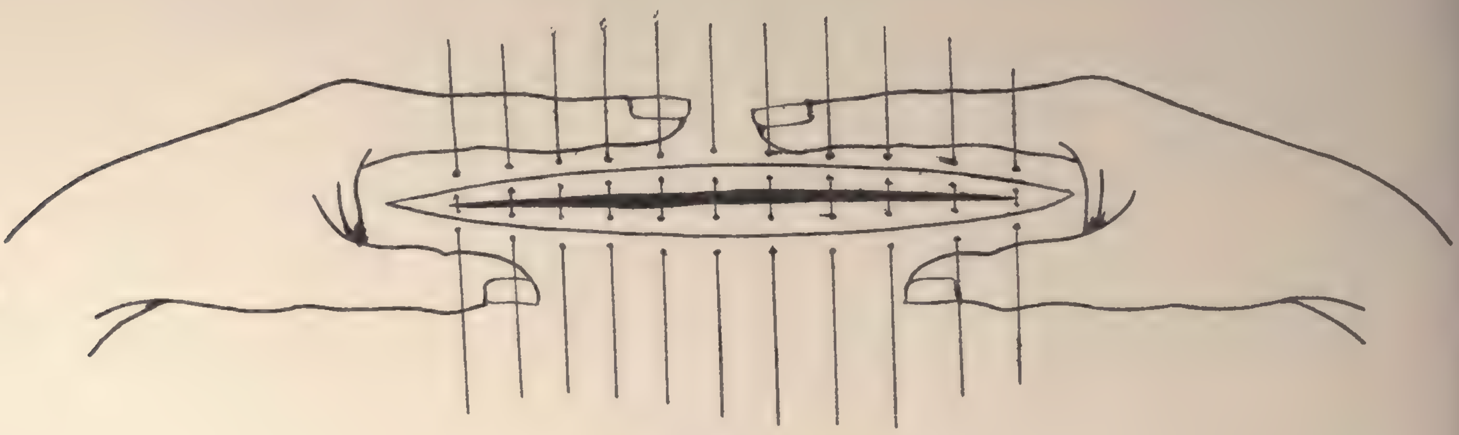


Fig. 5.

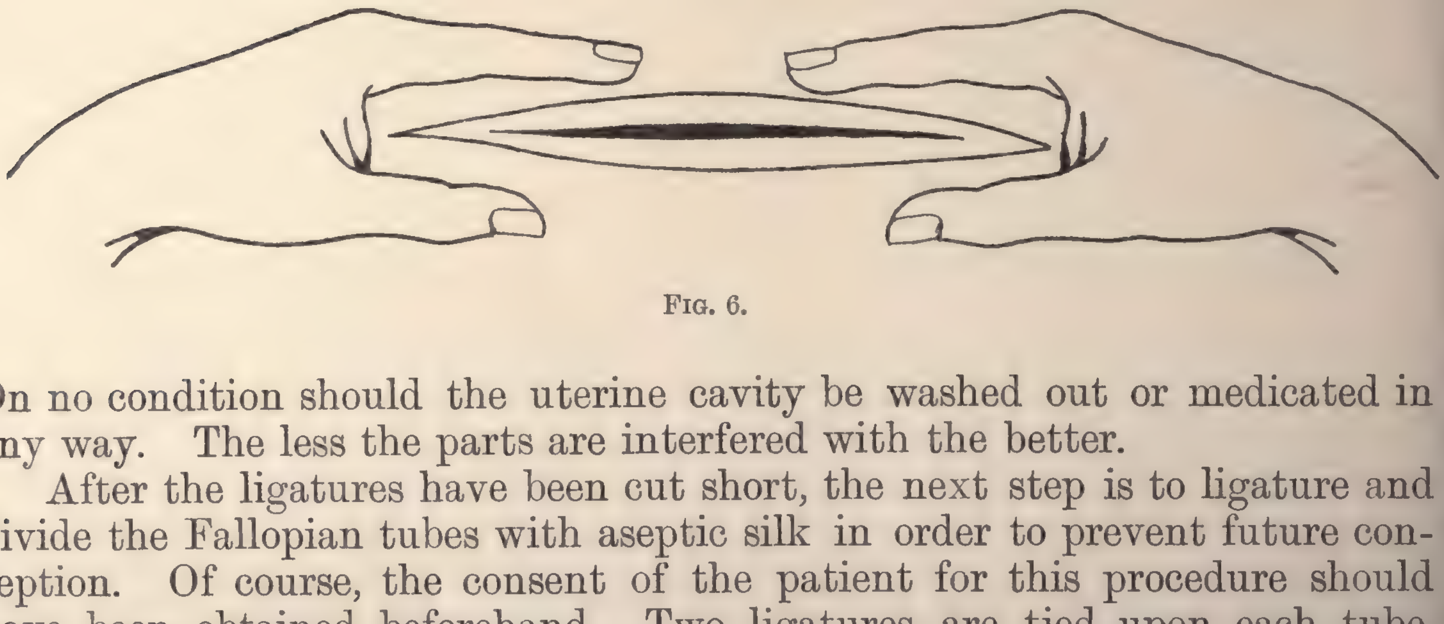


Fig. 6.

On no condition should the uterine cavity be washed out or medicated in any way. The less the parts are interfered with the better.

After the ligatures have been cut short, the next step is to ligature and divide the Fallopian tubes with aseptic silk in order to prevent future conception. Of course, the consent of the patient for this procedure should have been obtained beforehand. Two ligatures are tied upon each tube, which is then divided between those points. This method is effective, and leads to no complications nor bad results, nor is menstruation interfered with. Next the cavity is cleaned by the removal of all clot, etc., and the uterus replaced. The external wound in the parietes is closed in the usual way with silk-worm sutures. The vagina should now be cleansed of all clot and sponged out, after which an antiseptic pad should be applied to the vulva.

The wound should be dusted with iodoform, and a few layers of gauze placed over the wound. This should be secured with plaster, both to prevent slipping of the dressing and strain on the sutures, in case of sickness or cough. A sheet of Gamgee is next applied, and then the bandage.

The after treatment consists of sips of warm water, say a teaspoonful every fifteen minutes for twelve or twenty-four hours, after which milk and soda may be given in increasing quantities. For a few nights a half-grain morphine suppository is given. The urine should be drawn off every six hours for two or three days, care being taken to thoroughly cleanse the parts before doing so.

On the fourth day two teaspoonfuls of glycerine in a couple of ounces of soapy water is administered as an enema, and if necessary some slight aperient by the mouth. The bowels having been moved, the patient is allowed chicken soup, fish, eggs, beef-tea, etc. If the child is to be nursed it may be put to the breast on the second or third day.

The abdominal sutures may be removed in from ten to fourteen days, and the patient allowed to rise at the end of four weeks. She should always wear an abdominal belt, and should be warned against kneeling when scrubbing floors, as this is apt to induce hernia from pressure and stretching of the cicatrix.

In review, it may be explained that rupture of the membranes, either intentionally or by labour, means a contraction of the uterine wall, and as a consequence a greater wounding of the uterine tissue in order to secure a sufficient opening to extract the child. Some operators, instead of using manual or pessary compression to prevent bleeding when opening the uterus, make use of an elastic ligature. The uterus is first everted, and the elastic ligature then passed round the cervix. This not only necessitates a much larger abdominal incision, but also induces asphyxia of the fœtus, and causes inertia of the uterus, as the organ does not so readily respond to kneading. Its use is therefore conducive to hæmorrhage. Veit, Doleris, and Pajot have blamed it for causing death from hæmorrhage, and Zweifel, Sänger, and Lusk have also noticed this complication.

Caruso advised the early removal of the ligature.

Another way of dealing with the uterine incision is by Sänger's method. In this procedure the muscular wall of the uterus is closed with from ten to fifteen sutures which approximate to, but do not include the mucosa; and between each suture two superficial sutures are inserted to unite peritoneum to peritoneum. Previously the peritoneum was separated from the muscularis, and a wedge-shaped piece of muscularis removed from each side, the base of the wedge being outermost. This done, the peritoneal flaps were folded into the wound and secured by the superficial stitches. Such a detailed process is quite unnecessary, as the sutures, as recommended by Cameron, secure perfect apposition, not only of the muscular tissue, but also of the peritoneum. In fact, most operators now make use only of eight or ten deep sutures, and reserve superficial sutures to secure contact where there is any gaping between the stitches. Such unevenness can be readily avoided by beginning in the middle and working towards each end, and by taking care to keep the sutures at regular intervals.

Porro's modification. The fatal results following the early Cæsarean section led to a modification of the operation. It had been found by experiment that the uterus in pregnant rabbits could be removed with better results than by simple section, and therefore it was concluded that similar results would follow in the case of women.

Blundell, in writing upon this subject, said such a method might prove an eminent and valuable improvement, but he also wrote, in speaking of deaths from peritonitis after Cæsarean section, that experience sometimes contradicts our most favourite opinions, and that something of the kind would be found to occur in the cases under consideration, as he had no doubt the risk of diffused peritonitis had been greatly exaggerated. How his surmise has proved true is seen in the present-day position of abdominal surgery.

Acting on the lines suggested, Storer of Boston in 1868 first practised amputation of the uterus after section. The case was one of pregnancy complicated with a fibroid of the uterus. He was interrupted by such an alarming hæmorrhage that he had to remove the body and fundus with the ovaries, but his patient died three days afterwards. This was an operation of necessity.

Porro first performed the operation as a matter of choice, as he considered it impossible to secure the uterine incision in Cæsarean section, so as to prevent the flow of blood and septic fluid into the peritoneal cavity. The results got under antiseptics in other abdominal operations encouraged him to make the attempt, and in 1876 he did so with happy results. Others took up the operation, and very quickly the old Cæsarean section was superseded by it, but only for a few years, as now Cæsarean section can be performed without the slightest danger from bleeding, peritonitis, septicæmia, or other dangers that Porro's operation sought to avert.

At the present day Porro's operation is an operation of exception, that is only necessary in some conditions, such as serious rupture of the uterus, or where labour is obstructed by a large fibroid. As regards the steps of the operation, it is to begin with similar to Cæsarean section. It is only after the uterus has been emptied that it varies, as at this point the uterus is everted and an elastic ligature applied round it, just above the os internum.

The uterine tissues are then compressed until the bleeding has ceased. The uterus is then removed, and the stump secured outside the abdominal wound, and maintained in position by needles and a serrenœud.

Porro, upon emptying the uterus, transfixed it with a trocar and cannula at the union of the body and cervix. He then withdrew the trocar, and passed two silver wires through the cannula, which was also withdrawn and the wires tied, one upon the right and the other upon the left side, including in their grasp the ovaries and tubes. This done, the uterus and appendages above the wires were cut away, whilst the stump was secured outside. The method has been improved by transfixing with needles and ligating with a serrenœud instead of with separate wires.

The stump is dusted with iodoform and dressed with gauze all round. The needles should be raised to allow of proper packing. A layer of sublimated Gamgee should be placed over all. It may require to be dressed daily, and the ligated portion usually separates about the tenth day, but the raw cavity requires regular dressing till perfectly healed.

It was urged as an important factor that Porro's operation prevented future conceptions, but this end is gained in Cæsarean section by the more simple method of tying and dividing the tubes.

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Ophthalmia. *See* Conjunctiva.

Ophthalmoplegia.

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Ophthalmoplegia.—The term, as generally used, means a paralysis of the ocular muscles due to a lesion situated in their nuclei of origin. It is usual to apply the term "ophthalmoplegia externa" to a paralysis involving the external ocular muscles, among which the levator palpebræ superioris is included, while the term "ophthalmoplegia interna" is employed when the paralysis affects the iris or the ciliary muscle. The terms "complete" and "incomplete" are also frequently used in describing ophthalmoplegia to specify whether all or only some of the muscles are affected. Cases where ophthalmoplegia externa and interna are present together are often described as "mixed." According as one or both eyes are affected, we may speak of a monocular or a double ophthalmoplegia. The above may all be combined in various ways. Usually both eyes are more or less affected. In complete cases, ophthalmoplegia totalis, movement is totally lost, giving the eyes a strange fixed appearance. The levator palpebræ escapes more frequently than the other muscles, and even when present the ptosis is often incomplete. Weakening of the orbicularis palpebrarum, so that firm closure of the eyelids is impossible, is occasionally seen, and it has been supposed that the facial muscles near the eye have a connection with the nucleus of the third nerve.

Certain forms of nuclear ocular palsy are congenital. Congenital ptosis, which is usually associated with weakness of the superior rectus, is of nuclear origin, but is not commonly included under the term ophthalmoplegia.

In infantile cases the course of the disease is slow, but usually progressive, although seldom attended by bulbar symptoms. Ptosis is much more frequent in these cases than in the ophthalmoplegia of adult life. Occasionally the facial nucleus is involved in the degenerative process.

Much more commonly the disease appears in adult life, involving at first usually one or two muscles only, and very often those taking part in associated movements. Many cases remain stationary, *i.e.* after a certain number of muscles have become involved the disease ceases to spread, some of the muscles remaining unaffected, and there being also no extension to the bulbar nuclei. Sometimes the disease is progressive, spreading slowly to involve the different nuclei of origin of the muscles or extending to the nuclei of other cranial nerves.

Ptosis is not very common in chronic ophthalmoplegia, and the internal muscles frequently escape (Swanzy).

The ocular symptoms are the same as those met with in other forms of ocular palsy. The general health is little affected unless other nuclei are involved. Some mental impairment is not infrequent. In addition to its occurrence as an entity, or in association with bulbar paralysis, chronic ophthalmoplegia is a very characteristic associate of several forms of nervous disease.

In tabes dorsalis diplopia from ocular palsy is a very frequent and often a very early symptom. The transient form Swanzy thinks due probably to vascular changes in the nuclei of origin, while the persistent paralysis of one or two muscles he thinks have more likely a peripheral origin. When a large number of muscles in both eyes are involved, or when associated muscles are singled out, a nuclear lesion is probably the cause. In general paralysis and in disseminated sclerosis ophthalmoplegia is occasionally observed, so too in exophthalmic goitre and some severe cases of multiple neuritis. The paralysis of accommodation following diphtheria is probably due rather to a peripheral than a nuclear lesion. Ophthalmoplegia interna is the term used by Hutchinson to indicate paralysis of the internal muscles of the eye characterised by dilatation of the pupil and loss of power of accommodation. The pupil and the ciliary muscles may, however, be affected singly—partial ophthalmoplegia interna.

Acute ophthalmoplegia is very much less common and less important than the preceding. Only a small number of cases have been described, and nearly all of these have been associated with chronic alcoholism. The disease is usually sudden in origin, with severe symptoms of cerebral disturbance, *e.g.* delirium, vomiting, somnolence. In some cases optic neuritis appears in the course of the disease. Death generally results within a fortnight from involvement of the bulbar nuclei. Small hæmorrhages in the nuclei have been found on post-mortem examination, probably associated with vascular disease. In some cases no gross changes have been observed in the nuclei, and the ophthalmoplegia observed may, in such cases, have been due to a toxæmic poisoning of the nerve centres. Subacute cases of nuclear palsy, with less violent symptoms and uncomplicated with bulbar lesions, have been recorded.

Ætiology of Ophthalmoplegia.—Syphilis and alcoholism are undoubtedly the most important factors in the causation of this disease. As Gowers points out, the relation to syphilis in these degenerative diseases is more often under than overrated. Among other causes have been quoted exposure to cold and poisoning by various agents, as lead, nicotine, CO_2, H_2SO_4, and the toxines of putrefying meat. Occasionally it has followed such diseases as influenza. In some cases no definite ætiological factor can be traced.

Pathology.—Gowers and others have demonstrated the degenerative processes in the nuclei, which consists chiefly in atrophy and disappearance of the nerve-cells, but the degenerative process doubtless affects the whole motor neuron.

Treatment.—The treatment is to be directed to the primary cause if such can be traced. The ocular palsies associated with tabes are very little affected by treatment, but sometimes pass off spontaneously. The cases associated with bulbar symptoms are usually unaffected by treatment. Cases where the disease is confined to the ocular nuclei, and where a distinct syphilitic origin can be traced, are often greatly benefited by vigorous treatment with mercury and iodide of potassium. As tonic and nerve stimulants, arsenic and strychnine, the latter hypodermically, have found most favour. Electrical treatment is not now considered to be of much value, though formerly much employed. If the diplopia is very troublesome it may be necessary to give the patient an opaque glass before one eye. The prisms required to enable the patient to fuse the double images are usually much too strong to be worn as spectacles. Operative treatment is occasionally indicated, especially in slight cases of long standing.

Diagnosis.—The chief points indicating a nuclear origin for an ocular palsy are bilateral occurrence, symmetrical affection of the muscles, rarity of ptosis, the paralysis of the external muscles without involvement of the internal, and *vice versa.* In complete paralysis of all the ocular muscles the lesion may be nuclear, or may be due to injury of the nerves at the base of the brain on their way to the orbits.

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Ophthalmoscope. *See* RETINA, RETINOSCOPY.

Opium. *See* TOXICOLOGY.

Optic Nerve. *See* RETINA.

Orbit, Diseases of the.

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See also GENERAL EYE INDEX, Vol. III.

CONGENITAL AND ACQUIRED MALFORMATIONS OF THE ORBIT.—The bony orbit is a pyramidal fossa, irregularly quadrilateral. The inside angles are rounded so that in section the shape is more conical than pyramidal. The base of the pyramid corresponding to the anterior aperture of the orbit, is directed forwards and a little outwards. The apex is at the optic foramen in the sphenoid bone. The inner walls of the two orbits are approximately parallel, while the temporal walls diverge so as to be nearly at right angles to each other.

The nasal wall, formed from behind forwards by the sphenoid, ethmoid, lacrymal and superior maxillary bones, is the thinnest, and constitutes but a slender partition between the orbit and the adjoining ethmoidal sinuses and the superior and middle meatus of the nose. Posteriorly, where the body of the sphenoid enters into its formation, the wall is thicker and more resistant. At its anterior border, between the superior maxillary and lacrymal bones, is the lacrymal groove leading to the nasal duct.

The roof of the orbit formed by the lesser wing of the sphenoid bone and the orbital plate of the frontal is very thin, especially in the middle and anterior portions, and is here readily perforated by disease or injury. In old age it may be so thin in places that the periosteum of the orbit and the dura mater of the anterior fossa of the skull are practically in contact. At the anterior and inner part it separates the frontal sinus from the orbital cavity.

The floor of the orbit is formed almost wholly by the superior maxilla and to a small extent by the malar and palate bones. It is for the most part thin, and separates the cavity of the orbit from that of the antrum.

Traversing it from behind forwards is the groove carrying the infra-orbital nerve and artery.

The outer wall is the strongest of the four, and in its surgical relations the least important. It is formed by the malar bone, the great wing of the sphenoid, and a small portion of the frontal bone.

The cavity of the orbit is connected with adjoining parts by three important apertures. At the apex is the *foramen opticum* passing through the base of the lesser wing of the sphenoid to the middle fossa of the cranium, and transmitting the optic nerve and ophthalmic artery. The *sphenoidal fissure,* sometimes called the superior orbital fissure, lies between the greater and lesser wings of the sphenoid; its inner end occupies the apex of the orbit, its outer narrower part is between the roof and the external wall. It communicates with the middle fossa of the skull and gives passage to the oculo-motor nerves (third, fourth, and sixth) and the ophthalmic division of the trigeminal nerve. The *spheno-maxillary,* or inferior orbital *fissure,* between the outer wall and floor of the orbit, leads posteriorly into the spheno-maxillary fossa, and anteriorly into the zygomatic fossa. At its hinder end the infra-orbital nerve enters the bony canal in the floor of the orbit.

The bony walls of the orbit are covered throughout by a thin periosteum, conveniently termed the "peri-orbita," which is directly continuous at the optic foramen with the dura mater and the dural sheath of the optic nerve. Its adhesion to the orbital walls is not very firm, except along the interosseous sutures and at the margins. Hence separation of the periosteum from the bone is readily induced by a collection of pus, or other products of disease, and is easily effected during operations when necessary.

Contents of the Orbit.—The contents of the orbit comprise the eyeball, optic nerve, ocular muscles, lacrymal gland, vessels and nerves. These structures are supported by connective tissue and orbital fat. The connective tissue forms certain fasciæ, which play an important part in the maintenance and control of the relative positions of the orbital structures. These are, chiefly, the tarso-orbital fascia, or palpebral ligament, attached to the margins of the orbit and to the tarsus of the upper and lower lid; the fascia connecting the extra-ocular muscles with each other and with the margin of the orbit as check ligaments; and the *fascia bulbi* (or Tenon's capsule), a fibrous capsule surrounding the eyeball and forming a sort of socket in which the globe rotates. It is continuous with the fascia of the recti and obliqui, and is reflected upon the tendons of these muscles where they pass through it.

The blood-supply is derived from the ophthalmic branch of the internal carotid artery, which enters the orbit through the optic foramen. The venous blood leaves the orbit by two main channels, the superior and inferior ophthalmic veins, which pass through the sphenoidal fissure to the cavernous sinus, into which they empty. There are numerous anastomoses between the branches of the ophthalmic veins and of the facial vein.

The nerves of the orbit are motor nerves to the ocular muscles (third, fourth, and sixth); and sensory nerves derived from the first (chiefly) and second division of the trigeminus. The ciliary ganglion, situated close to the temporal side of the optic nerve, near the apex of the orbit, derives motor fibres from the third nerve, sensory fibres from the ophthalmic division of the trigeminus, and sympathetic fibres from the plexus on the carotid artery.

The bony cavities in proximity to the orbit, and which are frequently in pathological relation to it, are the frontal, anterior and posterior ethmoidal, sphenoidal, and maxillary sinuses, and the nasal fossæ. Disease in any of these cavities may extend to the orbital tissues, or may lead to distortion of the walls of the orbit and displacement of its contents. The period of development of the sinuses should be borne in mind. The maxillary sinus or antrum begins to be formed during the fourth month of fœtal life; the frontal, ethmoidal, and sphenoidal sinuses first appear during childhood, but remain of small size up to the age of puberty, when they undergo great enlargement. In old age these sinuses all increase in size by the absorption of the cancellous bone around them.

Malformations of the Orbit.—These are usually congenital, and for the most part occur in connection with gross developmental anomalies of the skull. In the microcephalic and oxycephalic deformity resulting from premature synostosis (Virchow), the orbits are often very shallow and the eyeballs greatly protruded. In cases of microphthalmos, or anophthalmos, the orbit may be much reduced in size, very narrow, with a defective roof, and absence of the optic foramen. Arrest of development of the bony walls is occasionally seen. The most usual site of this deformity is the upper inner part corresponding to the suture between the frontal and ethmoid bones. Through the gap in the bone the cerebral meninges may protrude and give rise to displacement of the eyeball and other symptoms.

Acquired malformations of the orbit are not uncommon. They are generally caused by encroachment on the orbital space by one or more of the neighbouring sinuses, as the result of disease. In hydrocephalus the orbit may undergo diminution in depth and the eyeballs become protruded by pressure of the intracranial fluid pushing forwards the bones at the apex of the orbit.

LITERATURE.—Quain's *Anatomy.*—Dwight, vol. i. *System of Diseases of the Eye.* Norris and Oliver.—Bull, *ibid.* vol. iii.—W. Czermak. *Die topogr. Beziehungen der Augenhöhle zu den umgebenden Höhlen und Gruben des Schadels.* Breslau, 1895.

INFLAMMATORY AFFECTIONS OF THE ORBIT

(1) *Beginning in the Periosteum or Bony Walls* . . . 551
(2) *Beginning in the Cellular Tissue* 553

1. Periostitis, or, more strictly, osteo-periostitis, of the orbital walls is not uncommon, and, like bone inflammations elsewhere, is, with the exception of the syphilitic form, most frequent in children. The disease most commonly attacks the thicker parts of the bones at or near the orbital margin; just as in the long bones, the ends where there is more cancellous tissue are more often the seat of inflammation than the shaft.

The signs of disease will necessarily differ according to the site of the lesion. In cases in which the disease is near the orbital margin no difficulty attends the diagnosis, but in instances of deeply-seated inflammation the diagnosis in an early stage may be far from easy.

Two forms of inflammation are met with: acute, in which suppuration and necrosis rapidly ensue, and in which considerable destruction of bone may result; and chronic, leading to slow and progressive loss of osseous tissue, and often to the formation of fistulous openings and of irregular bony nodules about the area of disease. The chronic form is the more common.

In acute periostitis the symptoms are usually severe. The attack may be ushered in by fever, rigors, headache, and gastric disturbance, accompanied or quickly followed by great pain in and around the orbit, with tenderness on pressure over the bony margins, even when the periostitis is deeply seated. The eyelids become red and swollen, tense and brawny, and the ocular conjunctiva congested and œdematous. Protrusion of the eyeball soon occurs, varying in degree according to the site of the periostitis; and although sometimes very marked, is not as extreme as in many cases of slowly-developing orbital disease. There may also be lateral or vertical displacement of the globe. The movements of the eyeball are restricted; but such limitation is, as a rule, less noticeable and less general than in cases of orbital cellulitis. Pronounced loss of movement in all directions is indicative of extension of the inflammation to the orbital cellular tissue. In severe cases in which there is great swelling and much interference with circulation, the cornea may rapidly become opaque and may slough, wholly or in part.

If the bone disease is in the anterior part of the orbit, palpation may disclose a more or less resistant and possibly fluctuating swelling; but frequently, owing to the œdema of lids and the extreme tenderness, it is impossible to gain much evidence by this method of examination. When situated more deeply the local lesion cannot be reached by the fingers. The signs are those of an acute painful inflammation, and until pus makes its way to the surface, or is found by exploratory incision, the diagnosis of periostitis remains in some doubt.

The chronic form of osteo-periostitis is a more insidious malady, and the inflammatory signs and symptoms are often very slightly marked. The pain is not severe. There may be no fever or other constitutional disturbance, and the objective evidence of disease may be limited to slight swelling of the lids and protrusion of the eyeball, with tenderness on pressure. Hence the diagnosis between an inflammatory condition and a new growth, such as sarcoma or osteoma, is sometimes very difficult. This is especially true of syphilitic periostitis, which, in the limited and slowly-increasing area of disease and its hardness to palpation, may closely resemble an exostosis.

If the site of the periostitis is near the orbital margin, there are œdema of the adjoining soft parts, thickening of the bone, and sometimes a fluctuating swelling. Exophthalmos may be absent throughout, or may develop only as a late symptom. The periosteum often becomes separated from the bone over a large area, and hence an abscess, though of considerable size, may be so diffuse as to cause but little displacement of the orbital contents. The abscess which forms tends to point anteriorly through the conjunctiva or the skin of the lids; it may, however, open into the nose or other cavities adjacent to the orbit, or pus may make its way through the roof of the orbit into the intra-cranial cavity. In very chronic cases in which there is little tendency to the formation of pus, great thickening of the periosteum may result, with the development of spicules and nodules of bone at the margins of the diseased area.

The common causes of orbital periostitis are—injury, syphilis, tubercle, and extension of disease from neighbouring sinuses and the nasal fossæ. According to Panas the majority of cases of orbital osteo-periostitis are due to infection from the nasal fossæ or the sinuses immediately adjoining the orbit.

In traumatic cases the disease is nearly always at or close to the margin of the orbit. There is no doubt that in many, probably the large majority, of such instances the disease is induced by injury in consequence of an unsound constitutional condition.

The syphilitic variety is almost confined to adults, and to those in the tertiary stage of acquired syphilis. Cases are, however, occasionally met with in children, the subjects of inherited syphilis. This form is generally chronic.

The tubercular variety is essentially a disease of childhood.

Treatment.—The general treatment of orbital periostitis will necessarily depend on the nature of the case. In severe instances in which the patient is acutely ill, treatment must be largely symptomatic. Opiates for the relief of pain, and quinine, and other antipyretic drugs should be employed, and the diet must be suitable for a patient in a febrile state. In the more chronic cases, especially those in tubercular children, dietetic and hygienic treatment is of great importance; the most useful drugs are such as cod-liver oil, maltine, and the phosphates of iron and calcium. In syphilitic cases, iodide of potassium or sodium in increasing doses should be administered. In feeble and badly-nourished patients, iron or cod-liver oil should be given in addition, while the diet should be nutritious and easily assimilable.

Local Treatment.—In acute cases, local depletion, by means of leeches applied to the temporal and malar regions, and the constant application of hot dressings, relieve the pain and tension of the tissues. As soon as suppuration occurs, an incision should be made, and the pus evacuated. In cases of deeply-seated disease it is not advisable to wait for the abscess to show itself at the surface. An incision should be made through the upper or lower eyelid at the site of greatest prominence, and an attempt made to reach the abscess cavity, observing great care to avoid the eyeball and its muscles, and the levator palpebræ superioris. The abscess, being opened, should be carefully washed out with a gentle stream of sterilised water or other aseptic solution (such as weak perchloride of mercury), and carefully examined for necrosed bone. The removal of carious bone from the orbital walls, except at the margins, is always a difficult matter, and, owing to the thinness of the bones, is often attended by considerable risk of injury to neighbouring important structures. In cases of orbital abscess, from whatever cause, it is important to make an external incision large enough to admit of the free escape of pus. Draining the orbit is always difficult, for with the patient in a recumbent position the path for the escape of pus is uphill, and hence the abscess cavity should be washed out more frequently than is necessary in some other situations.

Permanent displacement, usually eversion, of one or other eyelid is a not infrequent result of osteo-periostitis in cases in which the disease has attacked the orbital margin. This cicatricial ectropion is often seen in the tubercular form of bone disease in children.

Deeply-seated periostitis may be followed by limitation of the ocular movements from adhesions between muscles and neighbouring structures, and occasionally by post-neuritic atrophy of the optic nerve.

2. Orbital cellulitis or orbital phlegmon is an inflammation of the cellular tissue of the orbit, which usually terminates in suppuration and orbital abscess. Exceptionally the inflammation may subside without the formation of pus. There is also a rare variety known as plastic cellulitis, in which the inflammatory exudation is of a fibrinous character, and there is very little tendency to the formation of pus.

Orbit cellulitis is generally one-sided, but occasionally both orbits are involved simultaneously. Extension or transference of inflammation from one orbit to another is sometimes seen. The affection is generally acute, but subacute and chronic forms are met with. In the acute form the chief local signs are rapidly-increasing swelling and redness of the eyelids; great injection and chemosis of the conjunctiva, which often overlaps the corneal margins; protrusion of the eyeball and early impairment of its movements, which later may be entirely in abeyance. In severe cases the eyeball may be excessively proptosed, the conjunctiva very œdematous, and rapidly-destructive ulceration of the cornea may ensue. The displacement of the globe may be lateral or vertical as well as forwards. Palpation seldom reveals local disease, but all the tissues are tense and resistant, and examination is difficult. The pain is severe, and fever and other evidences of constitutional disturbance are often very marked. Sight may or may not be defective; this depends upon involvement or escape of the optic nerve. In some instances when the disease has lasted for a few days, neuro-retinitis may be discovered on ophthalmoscopic examination; frequently, however, it is impossible to obtain a view of the fundus oculi.

After a varying period, seldom less than three days, the skin of the lids becomes dusky and thinned, and pus makes its way to the surface; the abscess may, however, open through the conjunctiva. The discharge is followed by relief of the subjective symptoms, and by diminution in the tension and duskiness of the lids, and the swelling of the conjunctiva.

In subacute or chronic cases the signs and symptoms are all less severe, and pus is longer in making its way to the surface.

The causes of orbital cellulitis are numerous. It is frequently traumatic, resulting from a septic penetrating wound, with or without the retention of a foreign body in the orbit. It occasionally follows fracture of bones of the orbital walls. Of non-traumatic causes the most common are extension of inflammation from the bony walls of the orbit, from neighbouring sinuses *e.g.* the frontal sinus, from the skin in facial erysipelas, or from the eyeball in panophthalmitis. Less frequently cellulitis arises by the spread of inflammation from the superior maxilla in diseased conditions of the teeth, from the pharynx and nose and nasal duct, and by septic thrombosis in pyæmic and submitted septicæmic states.

Treatment.—This will vary somewhat according to the severity of the case. In all instances, however, the evacuation of an abscess cavity as soon as formed is imperative. If the case be acute, with much swelling and tension of lids and protrusion of globe, an incision should be made before the abscess points. In slighter cases local depletion by leeches and repeated hot compresses may be employed at first, and the abscess opened as soon as its existence can be definitely determined. Unless the abscess be pointing, the incision should be made at the site of greatest tension, but preferably towards one end of the eyelid. A narrow knife should be entered deeply into the orbit, parallel to the nearest wall, carefully avoiding the eyeball and other important structures. The external opening should be large. The abscess being evacuated, careful examination with the probe should be made to ascertain the site and size of the cavity, and whether it leads to carious bone, or is in communication with adjoining sinuses. Thorough irrigation of the abscess cavity should be employed, a drainage tube inserted and warm dressings applied. In cases of orbital cellulitis from facial erysipelas, early and free incisions should be made to prevent extensive sloughing of the eyelids. When panophthalmitis occurs, the eyeball should be incised, and the contents evacuated. The shrunken globe should be removed at a later date.

The general treatment in cases of orbital cellulitis must be governed by the condition of the patient. In debilitated patients stimulants and good feeding are necessary. If the pain is severe, opiates should be administered: quinine is a useful drug in most cases.

Results of Orbital Cellulitis.—In mild forms no permanent damage may ensue. In severe cases the orbital tissues may become adherent and remain bound by cicatricial bands, so that the movements of the globe are much impaired. Partial or complete loss of sight from optic nerve atrophy is not uncommon, and is an almost constant result of the cellulitis accompanying facial erysipelas. Blindness may also be caused by damage to or destruction of the cornea. Fatal results occasionally accrue from extension of inflammation to the meninges, or by phlebitis of the orbital veins spreading to the cavernous sinus.

THROMBOSIS OF THE CAVERNOUS SINUS.—This is not primarily a disease of the orbit, but as in some respects it closely resembles orbital cellulitis, a brief description seems desirable. Thrombosis of the cavernous sinus necessarily leads to obstruction in the orbital veins, and it is probable that in cases in which the symptoms most nearly approach those of orbital cellulitis, phlebitis of these veins has occurred. The usual symptoms in this affection are a varying degree of exophthalmos, with limitation of ocular movements, œdema of the eyelids and conjunctiva, and pain, which is often very severe. There may be, as later developments, paralysis of ocular muscles, and anæsthesia over the area of distribution of the ophthalmic division of the fifth nerve, from pressure on the nerve-trunks in the sinus. Vision is usually impaired, and the retinal veins are found greatly distended. Œdema of the skin in the mastoid region is present in many cases. If the thrombosis is septic, abscesses may form in the eyelids or orbital tissues. In many cases the diseased process extends from one cavernous sinus to that of the opposite side, by way of the circular sinus, and symptoms then develop in the second orbit.

The most common cause of thrombosis is inflammation of the sinus, due either to infection from some septic focus or to a general pyæmic condition, or to extension of inflammation to the sinus from carious bone in the vicinity, or from the ear in otitis media. Less common causes are fractures of the base of the skull, and conditions of health which encourage spontaneous clotting, such as chronic phthisis and marasmus.

The prognosis is very unfavourable. Most cases terminate fatally, usually in coma. The duration varies from 24 hours to two or three weeks, but in one instance three months and a half elapsed between the onset of ocular symptoms and death.

The serious constitutional disturbance, the association of cerebral symptoms, the œdema in the mastoid region, and the frequent involvement of the second orbit, are important signs in the diagnosis of this disease from orbital cellulitis. Paralysis of ocular nerves, both motor and sensory, is more frequent in thrombosis cases, and sometimes occurs as the earliest symptom, before the onset of exophthalmos or œdema.

INJURIES OF THE ORBIT[1]

Injuries of the Soft Parts.—These are almost always due to laceration of structures by penetrating wounds, or the entrance of foreign bodies, such as chips of metal, bullets, or shot pellets. The immediate result of penetrating wounds is hæmorrhage into the orbital tissues, and if large or numerous vessels have been divided, a hæmatoma of considerable size may form. This is followed by exophthalmos, which may rapidly become so great as to endanger the cornea from exposure and interference with its nutrition. The extravasated blood usually finds its way forward, and appears under the ocular conjunctiva and beneath the skin of the eyelids. Under treatment by rest and the application of ice, bleeding usually ceases, and as the extravasated blood undergoes absorption, the eyeball resumes its normal position. If the wound be septic, suppuration may occur in the blood-clot, and an orbital abscess result. Extensive hæmorrhage in the orbit may also be caused by severe blows without a penetrating wound. In such instances there is usually fracture of the bony wall of the orbit.

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[1] Injuries of the eyeball and eyelids, see Vol. III.

Complete division of one or more of the recti muscles is an occasional result of perforating wounds by sharp instruments. The eyeball may wholly escape injury in such cases. Deviation of the eye and loss of movement in one direction, and diplopia will indicate the nature of the injury.

Division or severe laceration of the optic nerve is a not uncommon result of penetrating wounds of the orbit by bullets or such implements as knitting-needles, pencils, etc., which make but a small external wound, and may not injure other important structures. In such cases there is immediate and generally permanent defect or loss of sight. The eye may, and probably will, appear uninjured, but will usually show dilatation of the pupil and loss or restriction of its reaction to direct illumination. Ophthalmoscopic examination reveals nothing abnormal at the time of or soon after the injury; but in the course of two or three weeks, or longer, signs of atrophy of the optic disc make their appearance. If the nerve has been wounded at a point anterior to the entrance of the *arteria centralis retinæ*, the ophthalmoscopic appearances will resemble those of embolism, namely, cloudiness of the retina, and shrinking of its arteries.

Foreign bodies of very considerable size may lodge in the orbit and give rise to no external signs by which their presence can be detected. On the other hand, they not infrequently cause some displacement of the eyeball and limitation of its movement, and occasionally complete dislocation of the globe.

If the missile has entered the orbit forcibly, it may traverse the cavity and pass through the bony wall. Perforation of the roof of the orbit and wound of the meninges or brain in this way is usually followed by meningitis or cerebral abscess and death. In children such a result sometimes occurs from a perforating wound by a small stick or similar implement with which the child is playing and upon which he falls. The stick is withdrawn, and as the wound appears trivial but little notice is taken of it until the onset of cerebral symptoms. The wound of entrance is sometimes in the conjunctiva beneath the upper eyelid and may easily be overlooked.

When the presence of a foreign body in the orbit is suspected the wound should be carefully probed. In the case of fragments of metal, stone, etc., examination by X-rays should be resorted to.

Injuries of the Bony Walls of the Orbit.—Fractures of the bony walls may result from direct or indirect violence. They are commonly caused by severe blows in the orbital region, with or without laceration of the superficial structures. They may involve any portion of the orbital wall. Fractures at the margin of the orbit are easily detected by the irregularity of outline and crepitation; small fragments of bone may be so completely separated as to be freely movable.

Fractures of the deeper parts of the orbital wall are more difficult of diagnosis. If the outer wall is involved, it is sometimes possible to detect crepitation or movement of the segments. When the inner wall has been fractured and communication with the respiratory passages established, emphysema of the orbital tissues usually occurs. This is followed by exophthalmos. Emphysema can be distinguished from hæmorrhage in the orbit by a feeling of crepitation in the tissues, the diminution of the swelling by pressure, and its increase during forced expiration. Bleeding from the nose is also usual in fracture of the inner wall. If the fracture is situated anteriorly, displacement of the lacrymal bone or of a fragment of the ethmoid bone may be discovered on careful palpation. Fracture of the floor of the orbit into the maxillary antrum may be followed by emphysema; and the infra-orbital nerve may be lacerated, causing anæsthesia over the area of its distribution.

Fracture of the roof of the orbit is generally caused by penetrating wounds, and is therefore most dangerous. It may, however, be due to indirect violence; and there being no objective signs, the earliest clear indication of the fracture may be the onset of symptoms of meningitis. If caused by a penetrating wound, examination by careful probing may afford evidence of the fracture. Such injuries are always serious, and when due to perforating wounds are fatal in a large proportion (over 80 per cent, Berlin) of the cases. Cerebral symptoms may not appear for some days after the injury.

In all cases of fracture of the orbital walls, extensive hæmorrhage into the soft parts may occur, inducing exophthalmos.

Fracture of the sphenoid bone, involving the optic foramen and damaging the optic nerve, is not very uncommon. It is caused by blows or falls upon the head, usually in the frontal region, and may or may not be associated with extensive fracture of the base of the skull. The ocular symptoms are immediate and generally complete loss of sight in the eye on the side of the injury, although in consequence of the mental condition of the patient the blindness often remains undiscovered for some days after the accident. No ophthalmoscopic signs of injury are found at the time, but in the course of a few weeks the optic disc invariably becomes atrophied. The blindness is due to laceration of the optic nerve in the foramen opticum, or, possibly, in some instances to compression of the nerve by extravasated blood. Recovery of vision is very unusual. Such cases may have a medicolegal importance, as owing to the absence of visible changes at first, simulation of blindness may be suspected.

Severe blows upon the orbit are occasionally followed by recession of the eyeball, and narrowing of the palpebral fissure, a condition to which the term *enophthalmos traumaticus* is applied. The enophthalmos may appear immediately after the injury, or not until the lapse of some weeks. In the former case, the cause is probably fracture of the floor of the orbit into the antrum of Highmore; in the latter the formation of cicatricial bands and shrinking of the orbital fat as a result of inflammatory changes.

Treatment.—Penetrating wounds of the orbit should be treated by careful cleansing and disinfection of the wound, and the provision of free drainage, if necessary. The skin wound, unless very minute, should be sutured, in part or in its whole extent, and, if ragged, should be trimmed, and its edges brought together as accurately as possible, to minimise the subsequent disfigurement. Ordinary surgical dressings are then applied. If a foreign body is detected, it should, as a rule, be removed; but small shot, or minute fragments of steel or other metal which have penetrated deeply, are usually better left undisturbed. In cutting down upon a foreign body in the orbit, great care should be taken to avoid injury of the ocular muscles and nerves, and the fragment should be removed with as little disturbance of the structures as possible. This precaution is especially needful when dealing with a long splinter of metal or wood, the deeper end of which may have penetrated the cranial cavity. If an abscess form in the track of the wound, it must be dealt with by incision and drainage, and other usual means.

When exophthalmos from hæmorrhage or emphysema is extreme, continuous pressure by a bandage should be employed, and great care be exercised in the protection of the cornea.

In cases of recent laceration or division of one of the recti muscles, an attempt should be made to find and unite the cut ends. If the injury is of long standing, other operative procedures may be needful.

Fractures of the orbital wall seldom require or admit of treatment designed to reduce displacement, but when the injury involves the margin of the orbit, it is sometimes possible to replace the fragments and keep them in position by careful bandaging. Small loose splinters of bone, especially if associated with a lacerated wound, should be removed. All cases of suspected deep fracture of the orbital walls, especially of the roof, should be considered serious, and carefully watched for the development of cerebral symptoms.

Tumours of the Orbit

The difficulty of satisfactorily classifying tumours of the orbit is evident from the very varied arrangement adopted by different writers. A rough, but useful, clinical division of orbital tumours is into solid, cystic, and vascular. The first group will include osseous, sarcomatous, and carcinomatous tumours, and some rarer growths; the second, congenital cystic formations and parasitic cysts; while in the third group are placed all varieties of angioma.

Tumours of the orbit are not uncommon. Statistics indicate that they account for rather more than 40 per cent of all kinds of disease of the orbit. Their frequency varies considerably with age. According to Hasner, the largest proportion of cases is met with in the first decade of life; the next largest in the second decade. Of the subsequent periods the fifth decade shows the greatest number. These statistics may be partially explained by the fact that most cases of congenital tumours come under observation and treatment during childhood.

Tumours may be primarily orbital, that is, originating in the tissues of the orbit, or, as is frequently the case, they may spread to the orbit from neighbouring structures in which they have arisen. The diagnosis between these two classes of cases, although difficult clinically, is important in reference to the question of operative treatment, and consequently of prognosis. A new growth which begins in, and is limited to, the orbit much more readily admits of complete removal than one which springs from the ethmoidal sinus, for example, and makes its way into the orbit. The difficulty in diagnosis is enhanced by the fact that tumours originating in the ethmoid, sphenoid, or frontal sinus may attain a considerable size, and remain undiscovered until their extension into the orbit gives rise to signs or symptoms which attract attention. Metastatic orbital tumours have been reported, but they are extremely rare.

The most frequent clinical sign of orbital tumour, and one which is common to all varieties, is exophthalmos. The degree and the direction of the displacement of the eyeball vary considerably, and are dependent upon the size and position of the tumour, and the presence or absence of coincident inflammation of the orbital cellular tissue. The degree of exophthalmos, however, bears no constant relation to the size of the tumour. If the latter be situated at the apex of the orbit, it may grow to a considerable size without causing much displacement of the globe. In cases in which the tumour attains a large size, the proptosis becomes extreme, the eye and other orbital contents being pushed forwards until the globe may be almost dislocated between the eyelids. Manipulation of the eye during the examination of such cases may readily lead to complete dislocation. The protrusion of the eyeball is seldom directly forwards. There is generally in addition some lateral or vertical displacement, and the direction of this is indicative of the position of the new growth. When the tumour originates in the optic nerve, or its sheath, the eyeball is displaced directly forwards.

The protruded globe in cases of orbital tumour offers a very variable resistance to backward pressure. In soft and very vascular growths, and in cystic or aneurysmal tumours, the exophthalmos can be appreciably reduced by pressing the eyeball into the orbit; whereas in cases of sarcoma and other solid tumours, especially osteoma, little or no alteration in the protrusion of the globe can be effected by pressure.

Derangement of the movements of the eyeball is another common symptom of orbital tumour, and is present to a greater or less degree in all cases in which displacement of the eye occurs. The loss of mobility may be slight and only in one direction, or all the ocular movements may be restricted. Limitation of movement is frequently due to mechanical interference with one or more of the ocular muscles by a solid growth, or a tense cyst pushing the muscle aside and stretching it, or growing round it. In some cases the muscle is invaded by new growth and disorganised, and in others the trunks of the motor nerves are involved by a tumour arising in the vicinity of the sphenoidal fissure.

In addition to loss of ocular movement there is, not infrequently, more or less ptosis, from paralysis of, or mechanical interference with, the levator palpebræ superioris.

In slight degrees of exophthalmos the eyelids may have a normal appearance, although pushed forwards by the protruding globe. As the exophthalmos increases, the eyelids, and especially the upper lid, become swollen, congested, and often dusky, and the enlarged veins become visible through the skin.

The visual disturbance induced by an orbital tumour varies very widely. Impairment of sight may occur as an early symptom, or not until the exophthalmos becomes extreme. It is due to atrophy of the optic nerve from pressure of the tumour, or to neuritis. In the former case the ophthalmoscope will reveal a pale atrophic optic disc, and in the latter a swollen inflamed papilla. The ophthalmoscopic changes may, however, be very slight, and merely indicative of obstruction to the return of blood from the retina. In cases in which good vision is retained, but the eye is displaced and its movement restricted, diplopia will be a prominent and annoying symptom.

If the exophthalmos is extreme, so that the lids cannot be made to cover the eyeball, the cornea is prone to suffer. Keratitis from exposure sets in, and rapid ulceration and sloughing may lead to the complete destruction of the cornea.

It is unusual for an orbital tumour to invade the eyeball, even in cases in which the growth originates in the optic-nerve sheath. Some of the more malignant forms, however, attack all the tissues with which they come in contact.

Examination of the orbit by palpation frequently furnishes important evidence, not only as to the existence of a tumour, but also as to its position, size, and other characteristics. Digital examination may enable us to determine whether the growth is cystic or solid, and whether it is fixed or movable. But, except in instances in which the tumour has extended far forwards, it is often difficult to reach it with the fingers. There is not much space between the eyeball and the orbital margin, and pressure with the fingers in this space renders the tissues so tense that careful palpation becomes extremely difficult. In cases of doubt as to the nature of a growth, puncture by a needle or trochar may materially assist the diagnosis; or an exploratory incision, and if necessary, removal of a small portion of growth for microscopical examination, should be resorted to. When there is uncertainty as to the source of a tumour, that is, whether it has originated in the orbit or extended to it from one of the neighbouring sinuses, examination, by trans-illumination, by means of an electric light in the patient's mouth, should be made. In this way the presence of a growth in the frontal or maxillary sinus or the nasal fossæ can be detected, by the obstruction it offers to the passage of light through these cavities.

Pain, as a symptom of orbital new growth, is of very varying severity, and is not constantly present. The pain may be due to involvement of sensory nerves by the growth, as well as to distension of tissues. It not infrequently radiates along the first and second divisions of the fifth nerve. Tenderness on pressure is not, as a rule, noticeable. Loss of sensation over the area supplied by the first and second divisions of the trigeminal nerve is occasionally caused by pressure upon or destruction of these nerve-trunks by the growth.

Tumours of the orbit but seldom lead to involvement of lymphatic glands which are accessible to examination. The explanation of this is that the lymphatics from the eyeball and the orbital tissues pass backwards through the orbit to empty into the internal maxillary glands. In cases in which the eyelids are involved, infection of superficial lymphatic glands may occur. The first to show this are the glands of the parotid region, and especially the præ-aural gland lying immediately below the zygoma and in front of the tragus.

Benign orbital tumours may lead to loss of sight and paralysis of sensory and motor nerves in the way already mentioned, but are seldom dangerous to life. Some varieties, *e.g.* osteomata, may endanger life by encroachment on the cranial cavity through the roof of the orbit. Malignant tumours of the orbit are frequently fatal, death resulting from extension of the growth to the base of the brain, or by metastatic deposits in vital organs.

Solid Orbital Tumours.—Of tumours which can be considered under this heading, the sarcomata are by far the most common. All kinds are met with, but the most frequent are the round-celled and spindle-celled varieties, while not a few have the histological characters of fibro-sarcoma. Myxosarcoma, cylindroma, and endothelioma also occur, though less commonly. Melanosarcoma of the orbit is rarely met with, and is probably always secondary to tumour of the uveal tract or of the skin of the eyelids, but cases considered primary have been recorded. Round-celled sarcomata are most common in young subjects, and spindle-celled tumours in those over forty years of age. Fibro-sarcoma is occasionally met with in young children.

Primary sarcoma of the orbit may originate in the bone or periosteum, in the connective tissue or muscles, in the lacrymal gland, or in the sheath of the optic nerve. These tumours are usually hard, with a smooth but often nodular surface; they are fairly sharply defined, and are not infrequently encapsuled. When very vascular, they are more or less compressible, and occasionally pulsation can be detected. Puncture of such a growth allows the escape of a yellowish or sanguineous fluid, which may lead to the faulty diagnosis of a cystic growth. A very myxomatous tumour may give ill-defined fluctuation on palpation. If growing from the periosteum the tumour is fixed, but when springing from other tissues it is usually slightly movable.

Sarcoma of the orbit is always malignant, although there are wide variations in the rate of growth, the readiness with which the tumour invades surrounding structures, and its liability to recur. The prognosis is unfavourable, but more decidedly so if the neoplasm has extended to the orbit from one of the neighbouring sinuses. Local recurrence and metastasis are, unfortunately, common.

Carcinoma of the orbit, when primary, originates in the lacrymal gland, and is the glandular variety, or adeno-carcinoma. Cancer originating in the skin of the eyelids, in the conjunctiva, or in the nasal passages, may extend deeply into the orbit and form a large tumour. When the lacrymal gland is the seat of disease, the tumour can be felt beneath the rim of the orbit. It is very hard and almost immovable. Its growth is not rapid, and it extends backwards into the orbit as well as anteriorly. This variety of carcinoma is met with in young adults as well as in the aged. The prognosis is very gloomy; local recurrence is frequent, and extension to neighbouring vital structures or metastasis in distant ones is not uncommon.

The remaining solid tumours of the orbit are non-malignant. Osteoma of the orbit occurs in two forms; in one, termed exostosis, the growth assumes the form of a distinct tumour; in the other, hyperostosis, there is a widespread hyperplasia of the bone, but no definite tumour. Exostosis is not only the most common variety of bony tumour of the orbit, but is also more frequent than exostosis of other parts of the skull. The tumour may arise from the orbital wall, or, springing from one of the neighbouring sinuses, especially the frontal, may grow through its wall into the cavity of the orbit. The favourite site of these tumours is the roof or nasal wall of the orbit, but they occasionally spring from the floor, and more rarely from the outer wall. Their greater frequency at the nasal and upper part is probably explained by the large proportion which originate in the frontal and ethmoidal sinuses. An exostosis may consist of either spongy or compact bone. The latter form is much more frequent, and the density and hardness of the bone are such that the growth is known as an ivory exostosis. Spongy exostosis, and others composed of bony and cartilaginous tissue are also met with. Panas states that the tumours which arise in the orbit are more frequently of the cancellous variety, and show more tendency to superficial expansion than do the ivory exostosis. Orbital exostosis is generally unilateral, but examples of bilateral and symmetrical growths have been recorded. Occasionally more than one tumour is found in an orbit. These tumours are generally of a roughly hemispherical shape, and have a wide base of attachment to the orbital wall; occasionally they are globular in form, and attached by a narrow pedicle; the surface is usually uneven and often nodular.

Exostosis of the orbit is a very slow-growing tumour, sometimes lasting for years before producing noticeable symptoms. It is in itself painless, but may induce pain by pressure on nerves or other structures. The direction of growth is chiefly into the orbit and towards the surface, but extension backwards and upwards is by no means unknown, and occasionally invasion of the intra-cranial cavity takes place. Nothing certain is known as to the ætiology of these tumours. It is not improbable that they grow from residues of embryonic cartilage.

The diagnosis is, as a rule, easy; but if the exostosis is at the inner, or inner and upper part of the orbit, it may be mistaken for a distended ethmoidal or frontal sinus, over which a shell of bone still remains. The latter, however, is not so hard as an exostosis, and a sense of fluctuation can nearly always be obtained. If necessary, puncture or attempted puncture should be employed to clear up any doubt.

Hyperostosis of the orbital walls is extremely rare. It may lead to great distortion of the bony walls, and the shape of the orbit may thus be entirely altered.

Lipoma of the orbit has been described, but is very unusual, if indeed it ever occurs as a primary growth. Its characters do not differ from those of fatty tumours elsewhere, and the symptoms to which it gives rise result from mechanical displacement of orbital structures, or pressure upon them.

Enchondroma of the orbit is almost unknown. The few cases which have been reported are open to question, and are certainly not examples of pure enchondroma.

Fibroma of the orbit—that is, a benign fibrous tumour—is very rare. A few cases have been placed on record, but there is generally a suspicion that such growths belong to the fibro-sarcomata, and are therefore malignant.

Plexiform neuroma of the orbit is also very unusual, although this form of new growth in the eyelids is not so uncommon. The growth, which is probably congenital, occupies the upper outer part of the orbit in the neighbourhood of the lacrymal gland, whence it may spread extensively into the orbit and to the temporal fossa. It forms a slowly-growing, painless mass, which may be so firm to the touch as to simulate sarcoma or carcinoma. Its diagnosis without an exploratory incision is difficult. After removal of the mass a further growth may develop in the same site.

Myxoma of the sheath of the optic nerve is another of the benign tumours arising in the orbit. This form of growth is met with chiefly in children and young adults. It develops slowly, generally quite painlessly, and at an early stage gives rise to defect of sight, and later to its complete loss. The eyeball is protruded directly forwards, or forwards and slightly downwards, and its movements are little, if at all, impaired. These two features generally enable an optic-nerve tumour to be distinguished from other orbital growths. Difficulty in diagnosis will arise, however, in those rare instances in which a sarcoma develops within the funnel formed by the recti muscles.

Cystic Tumours of the Orbit.—The most frequent are the congenital dermoid cysts, which result from the invagination of a portion of the epidermis at an early period of development. Like dermoid tumours in other parts of the body, their walls have a structure similar to that of normal skin, the epidermis being placed internally. The cyst wall possesses the usual appendages of skin — namely, hair and sebaceous glands, and sometimes sweat glands. The contents of these cysts are composed of accumulated secretion from the skin glands, desquamated epithelium, and usually large numbers of hairs. Occasionally teeth have been found attached to the wall, or free in the cavity. In some instances, instead of a sebaceous material, the cyst contains an oily or honey-like fluid. These tumours, which are generally unilocular, are situated in the anterior part of the orbit, most commonly near the nasal wall. They grow slowly, and may attain a considerable size. They produce no symptoms, except such as are due to displacement of orbital structures. Their tendency is to protrude anteriorly, and they can usually be easily seen and felt through the skin of the eyelid as round, slightly movable, elastic growths. The diagnosis is not, as a rule, difficult, but in infants the variety of tumour to be next described may be mistaken for a dermoid cyst. This error in diagnosis, if it led to operative treatment, would be very serious.

Meningocele or encephalocele of the orbit is a congenital cystic tumour, the wall of which is formed by a protrusion of dura mater into the orbit. The sac thus formed may contain only cerebro-spinal fluid (meningocele), or in addition brain substance (encephalocele). This variety of tumour is most frequently situated at the inner upper part of the orbit, the aperture through which the hernia occurs corresponding to the suture between the ethmoid and frontal bones. The growth is fluctuating, covered by healthy skin, and by pressure can be reduced in volume, though such pressure may give rise to unpleasant cerebral symptoms. If large and superficial, it shows cardiac and respiratory oscillations, as do the unclosed fontanelles. Orbital meningocele is usually unilateral, and rapidly increases in size; the subjects of it seldom live many weeks.

The features which chiefly distinguish meningocele from a dermoid cyst are its firm attachment to the bony wall of the orbit, the existence of an aperture in the bone which can often be detected by the finger, the effect of pressure on the tumour, and the pulsation transmitted to it from the brain. A careful puncture of the cyst under strictest precautions as to sepsis would finally settle a doubtful diagnosis.

A rare form of congenital cyst of the orbit occurs in association with microphthalmos or apparent anophthalmos. The cyst is placed in or immediately behind the lower eyelid, is filled with a thin serous fluid, and is connected with the rudimentary eyeball by a thin hollow pedicle, or a broad attachment by which the two cavities communicate. Retinal structures can usually be found in the cyst wall, and it is thought that these cysts are anomalous developments from the embryonic tissue which normally forms the eyeball.

Parasitic Cysts.—Two varieties are met with, the cystic form of tinea echinococcus (hydatid), and of tinea solium (cysticercus). Hydatid cyst of the orbit is by no means common. Indeed, compared with other parts of the body, and especially the liver, the orbit is very rarely the seat of this entozoon. It is most frequent in the young, and in the male sex. There are no symptoms which clearly distinguish this disease from other deeply-seated and progressive tumours in the orbit. Pain is often severe, and there are, both in the extra-ocular and intra-ocular vessels, signs of obstruction to the circulation. In doubtful cases the cyst should be punctured and some of its contents drawn off. The fluid of an echinococcus cyst is watery, clear, and contains a large proportion of chloride of sodium, and a mere trace of albumen. Hooklets may be, but are not constantly, found on microscopic examination. The peculiar laminated character of the true cyst wall after removal clears up any doubt as to its nature, even in cases, not uncommon, in which no daughter cysts or scolices can be found.

Cysticercus of the orbit is extremely rare. In the few recorded cases the tumour has developed in the anterior part of the orbit, and has presented the ordinary characters of a cystic growth.

Two other rare forms of cyst of the orbit may be referred to—namely, hygromata, which are thought to arise in the bursæ of the ocular muscles, and blood cysts. The latter are, in some instances at least, dermoid cysts into which hæmorrhage has occurred.

The cystic tumours of the orbit are all benign growths, and rarely dangerous to life. Some forms may extend through the walls of the orbit to the intra-cranial cavity, and in this way lead to a fatal issue. Suppuration in an orbital cyst may be followed by septic meningitis and death.

Vascular Tumours of the Orbit.—The vascular new growths met with in the orbit are capillary and cavernous angioma, and lymphangioma.[1] The latter variety is excessively rare; about four undoubted cases have been recorded.

Capillary angioma or nævus is a congenital growth which apparently does not originate in the orbit, but extends to it from the skin of the lids or face. It is sometimes associated with hypertrophy of fatty tissue, and to such a combination the term angioma lipomatodes has been given.

Cavernous angioma usually originates in the orbit. The tumour is often deeply seated, of slow growth, and forms a mass which, though soft at first, becomes much harder in the later stages from an increase in the connective tissue in and around it. Vision is not often affected, but blindness due to atrophy of the optic nerve is occasionally met with. Pain is not a prominent symptom. The sexes are equally liable, and the disease may appear at any age. The ætiology of cavernous angioma is doubtful. It is probably sometimes congenital. In a few instances there has been a definite history of injury preceding the development of the tumour. It is frequently, but not invariably, situated within the funnel formed by the recti muscles, and, like a tumour of the optic nerve, displaces the eyeball directly forwards. The tumour is often encapsuled, and hence easy of removal.

In addition to the ordinary signs of orbital tumour, cavernous angiomata present certain characteristics. They are variable in volume, diminishing under pressure, and increasing when there is venous obstruction, as in crying or stooping. They often show spontaneous pulsation, but have no bruit or thrill. As the tumour increases in size it extends forwards, and may become visible as a bluish mass through the skin, and dilated vessels may appear in the eyelids.

Treatment of Tumours of the Orbit.—Complete removal of the tumour is the only treatment applicable to malignant growths. Unfortunately, in many cases of sarcoma and carcinoma the growth is either not primarily orbital, or has extended beyond the limits of the orbit before the patient comes under observation, and its complete removal is then impossible.

Small encapsuled growths, and tumours of the optic nerve, can occasionally be removed without sacrificing the eyeball. Two methods may be employed to attain this result. In the first, an incision is made through the conjunctiva on the temporal side of the eyeball, the external rectus muscle separated from the globe, and the eye rotated forcibly inwards. After removal of the growth the eye is rolled back into position, and the rectus muscle reattached. In the second (or Krönlein's) method, an osteoplastic flap is made of the outer wall of the orbit, the periosteum carefully separated from the bone and then incised, exposing the orbital contents. After taking away the new growth the flap is replaced.

In all cases in which a malignant tumour cannot be satisfactorily removed without sacrificing the globe, excision of the eye should be first performed. If the tumour is then found to be extensive and to involve the periosteum or bone, the whole of the orbital contents should be removed, and chloride of zinc paste applied to the orbital walls after bleeding has ceased, in order to destroy any portions of tumour which have been left behind. In spite of such vigorous methods recurrence is by no means uncommon, and a second, or even a third, operation may be necessary.

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[1] Aneurysmal formations are considered under a separate heading.

Exostosis of the orbit frequently admits of removal, and no other treatment of the tumour is of any avail. If the growth is large, removal of the eyeball may be necessary as a preliminary step. The operation is always difficult and tedious, and by no means free from risk. If attached to the roof of the orbit, attempted removal of the growth may be followed by fatal meningitis. Of sixteen cases, in which the tumour sprang from the roof of the orbit and in which operation was performed, six were fatal (Berlin).

In operating, the exostosis should be exposed, the periosteum incised and carefully peeled off, and the base or neck of the growth uncovered. A chisel is then used to the base, numerous small cuts being made, until the bony mass becomes loosened. In some cases in which the bone is extremely hard, the base of the tumour may be first drilled by a dental drill in several places, and separation completed by using a chisel. If the tumour be pedunculated, its removal is usually easy. In cases in which, for any reason, removal of the tumour cannot be attempted, and in which there is much exophthalmos, it may be advisable to excise the eyeball for the relief of pain.

Non-malignant solid tumours of the orbit—for example, lipoma—should be extirpated with as little disturbance of the surrounding structures as possible.

Dermoid cysts and parasitic cysts are best treated by complete removal. In dealing with dermoids, every endeavour should be made to dissect out the cyst completely and without opening it. Great difficulty is experienced in removing a collapsed cyst, and if portions of the wall are left, recurrent growths will form. Cystic tumours should be cut down upon at their most prominent part, and every endeavour should be made to avoid injury to important structures, such as the ocular muscles or nerves.

The treatment of cavernous angiomata should, whenever possible, consist of complete extirpation. In many instances, especially if encapsuled, the whole of the new growth can be removed. When the tumour is too extensive for removal, repeated electrolysis is useful, and eventually induces considerable diminution in the size of the tumour, and a gradual decrease in the displacement of the globe and other structures.

PULSATING EXOPHTHALMOS.—The term pulsating exophthalmos is applied to a group of cases in which protrusion of the eyeball and pulsation of the orbital structures are the most noticeable features. In their clinical characters, all cases included under this heading have much in common, but in their pathology they exhibit considerable variation. The name should not be applied to cases of tumour of the orbit in which pulsation can be detected.

The general features of pulsating exophthalmos are as follows:—The eyeball is protruded directly forwards, or forwards and downwards; the conjunctiva and eyelids are swollen, and their blood-vessels dilated and tortuous. The exophthalmos is sometimes so extreme that the eyelids cannot be closed. If the hand is placed upon the protruding structures, distinct pulsation, and frequently a thrill, are felt, and if the ear is applied, a soft blowing sound is heard. Not infrequently a compressible pulsating mass can be detected near the inner angle of the orbit, between the eyeball and the upper wall. The ocular movements are restricted, and occasionally there is partial or complete anæsthesia of the eyeball and other structures supplied by the first division of the trigeminal nerve. On ophthalmoscopic examination it is usual to find the retinal arteries narrowed and the veins greatly distended, tortuous, or even varicose, and sometimes pulsating. Occasionally the optic disc is swollen, and hæmorrhages from the retinal vessels are visible; in some cases there is atrophy of the optic disc.

The subjective symptoms are pain, often severe and persistent, and a continual noise, which is usually very distressing to the patient. The noise is variously described as "humming," or "roaring," and is likened to the sound of escaping steam or falling water. Vertigo is also a frequent symptom. Failure of vision may or may not be present. If the protrusion of the eyeball is extreme, infiltration and ulceration of the cornea are likely to ensue.

By firm pressure the exophthalmos can be diminished, and sometimes the eyeball restored to its normal position; but as soon as the pressure is removed, the globe again becomes prominent. Compression of the common carotid artery on the same side leads to recession of the globe, and arrest of the pulsation and thrill. The noise noticed by the patient is also stopped or greatly lessened.

Two groups of cases of pulsating exophthalmos are described, the onset and course of which exhibit some differences. In the *spontaneous* or *idiopathic* variety the onset is usually sudden, and ushered in by severe pain, followed by a roaring or hissing noise, which persists with increasing vehemence. In a short time, varying from a few hours to a few days, exophthalmos develops, accompanied by pulsation, thrill, and perhaps failure of vision. In the *traumatic* cases the onset is more gradual, the symptoms appearing after a severe head injury, often with fracture of the base of the skull, from which the patient may have been unconscious for hours, or even days. The noise may be the earliest symptom complained of, and is followed by exophthalmos and other signs. The condition is usually fully developed within six or eight weeks of the injury.

In cases, whether idiopathic or traumatic, which progress rapidly, the swelling of the lids and conjunctiva may be so great as to suggest orbital cellulitis. Spontaneous pulsating exophthalmos is much more common in females and in middle age. The traumatic variety is more frequent in the male sex, and may occur at any age.

The pathology of pulsating exophthalmos is much less familiar than are its clinical characters. Comparatively few cases have been examined after death, and in some of these no adequate explanation of the symptoms was found. The lesion which has been most frequently discovered post-mortem is rupture of the internal carotid artery in the cavernous sinus. As a result of this the blood-stream escapes into the venous sinus, and the latter, as well as its communicating veins, become greatly distended and pulsating, forming an arterio-venous aneurysm. In spontaneous cases the rupture occurs in an artery with very degenerate walls, or aneurysmal dilatation and thinning. In the traumatic variety the injury to the blood-vessel is inflicted by a splinter from a fractured bone, or by a bullet or other missile which penetrates the skull. Other conditions which have been found post-mortem are aneurysm of the carotid artery in the cavernous sinus, aneurysm of the ophthalmic artery either before its passage through the sphenoid bone or in its orbital portion, and thrombosis of the cavernous sinus and ophthalmic veins.

Spontaneous cure of pulsating exophthalmos has occurred, but is quite exceptional. The disease is usually progressive, and, unless arrested, leads to a fatal termination after an interval varying from a few weeks to two or three years. Death results from complications, such as repeated hæmorrhage (chiefly in traumatic cases) or from cerebral lesions.

The diagnosis of pulsating exophthalmos presents no difficulty; but it is by no means easy to distinguish with certainty the different varieties. The most important diagnosis to make is between a purely vascular lesion and a pulsating tumour of the orbit. This is especially needful in the case of malignant growths. Such difficulty arises only in instances of slowly-developing exophthalmos which is clearly not traumatic. In cases of tumour the protrusion of the globe is less frequently straightforwards, pulsation is less noticeable, and as a rule no humming or other noise is heard by the patient. Moreover, the effect of external pressure or of compression of the carotid artery upon the exophthalmos is much less than in aneurysm. If the tumour can be reached with the finger it is firmer and more resistant than true pulsating exophthalmos.

Treatment.—The amelioration of symptoms induced by temporary compression of the carotid artery is a clear indication as to the treatment of pulsating exophthalmos. The two most useful surgical measures are (*a*) compression and (*b*) ligature of the common carotid artery. Either digital or instrumental pressure may be employed. The former has proved the more effectual, but there are often difficulties in its execution. In successful cases treated by compression, improvement has begun about the third day, but the duration of treatment has varied from four to eighteen days. It is only in the idiopathic variety that compression of the artery offers a reasonable chance of success, and even in this variety the results of treatment are not very encouraging. Keller reports one success in seven cases.

Ligation of the common carotid artery has given better results than any other procedure, and in successful cases the cure has been complete in six or seven weeks. The records of this operation during recent years are very encouraging, and improved surgical methods have robbed it of nearly all its former risks, such as wound infection. In a small proportion of cases, however, disturbance of cerebral functions and death have followed the ligature of the carotid. As a rule the effect of ligation is immediate and very marked. The pulsation and bruit and the subjective noises disappear, and the exophthalmos and swelling of lids and conjunctiva steadily become less. In some instances a return of all the symptoms is noted a few days, or as long as one month, after ligature of the artery. When this occurs, the common carotid of the opposite side, or the external carotid of the same side, should be tied.

Other methods of treatment which have been employed in pulsating exophthalmos are repeated electrolysis and the injection of coagulating fluids. The latter plan is unsafe, and has given no satisfactory results; and electrolysis has proved of little value in true arterio-venous aneurysm.

INTERMITTENT EXOPHTHALMOS. — Under this name cases have been described in which the eyeball becomes proptosed on stooping or in any way obstructing the return of venous blood from the orbit. The condition has also been termed "alternating enophthalmos and exophthalmos," and by French writers, "exophtalmie à volonté." This unusual affection occurs chiefly in the young, and often develops suddenly. When once established the exophthalmos can always be induced by stooping. When the head is erect, the position of the eyeball may be normal, but in the majority of instances there is a varying degree of enophthalmos. The movements of the globe are unrestricted, and vision is usually unimpaired.

The pathology of this condition is still imperfectly understood. As the exophthalmos can be induced by compression of the jugular vein, and as dilated veins are occasionally visible through the skin of the lids, a varicose condition of the orbital veins is assumed to be present. In some recorded cases a varicose tumour could be felt in the orbit. The enophthalmos generally present indicates shrinking of the cellular tissue of the orbit.

So long as the exophthalmos remains intermittent no treatment is necessary. The patient soon learns to avoid such positions or muscular efforts as induce proptosis, or to prevent its development by pressure over the eyeball.

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